

# **Phase-4: Project Analysis**

## **Total Maximum Daily Load for Fecal Coliform in the Lower Salinas River Watershed, Monterey County, California**

***Final Preliminary Project Report***

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## 1. PROJECT DEFINITION

### 1.1. Introduction

This Project Report (Project) addresses impairment of the Salinas River (River) and several of its tributaries due to elevated density of fecal coliform.

Section 303(d) of the Clean Water Act requires the State to establish a Total Maximum Daily Load (TMDL) for fecal coliform at a level necessary to attain water quality standards. The State must also incorporate into the TMDL seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between load limits and water quality.

Some fecal coliform genera are pathogenic to humans. Fecal coliform and a subset of fecal coliform, *E. coli*, are used as indicators for the presence of other pathogenic organisms. Fecal coliform and *E. coli* will be referred to as indicator bacteria for the purposes of this report.

Note that the units of *density* and *concentration* are used synonymously in this report when referring to numbers of bacteria in a stated volume of water.

Numeric targets for indicator bacteria are discussed in the Numeric Target section of this report; see Section 6 for this discussion.

### 1.2. Project Area

The lower Salinas River Watershed (Watershed) comprises, for the purposes of this Project, the watershed area contributing flow to the Salinas River from the town of Gonzales, downstream to the mouth of the Old Salinas River Estuary. The bodies of water included in this project include:

1. Salinas River (Lower) (from Gonzales downstream to the Salinas River Lagoon)
2. Salinas River Lagoon (north)
3. Old Salinas River Estuary
4. Tembladero Slough
5. Salinas Reclamation Canal
6. Gabilan Creek
7. Alisal Creek

The Salinas River Lagoon (north), hereafter referred to as the Lagoon, is included in this Project because, as will be discussed later in the report, it carries fecal coliform densities exceeding state water quality criteria. In addition, the Lagoon has connectivity with other listed bodies of water addressed in this project.

All of the bodies of water listed above, with the exception of the Lagoon, are listed as impaired on the Clean Water Act (CWA) 303(d) list with fecal coliform listed as the pollutant/stressor.

The subject area of this Project is illustrated in Figure 1-1.

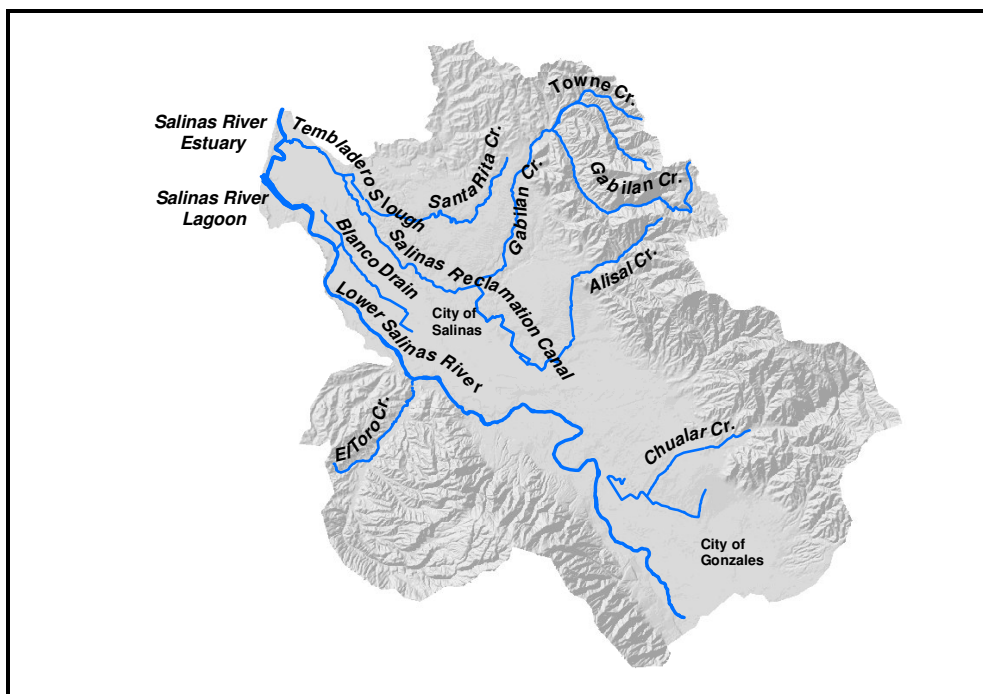


Figure 1-1 Lower Salinas River Watershed

### 1.3. Beneficial Uses

The Central Coast Water Quality Control Plan (Basin Plan) identifies beneficial uses that bodies of water in the Central Coast Region must support. Some of the beneficial uses are protected with corresponding water quality objectives, i.e., numeric and/or narrative water quality criteria. Table 1-1 identifies the bodies of water in the Project watershed and corresponding beneficial uses applying to those bodies of water.

Table 1-1 Beneficial uses in the Project area

	SALINAS RIVER From Chualar to Spreckles	SALINAS RIVER downstream of Spreckles	SALINAS RIVER LAGOON (NORTH)	OLD SALINAS RIVER ESTUARY	TEMBLADERO SLOUGH	SALINAS RECLAMATION CANAL	GABILAN CR.	ALISAL CR
MUN	X	X					X	X
AGR	X	X					X	X

GWR	X						X	X
REC1	X		X	X	X	X	X	X
REC2	X	X	X	X	X	X	X	X
WILD	X	X	X	X	X	X	X	X
COLD	X	X	X	X				X
WARM	X	X	X	X	X	X	X	X
MIGR	X	X	X	X				
SPWN			X	X	X		X	X
BIOL			X	X				
RARE			X	X	X			
EST			X	X	X			
FRESH		X						
COMM	X	X	X	X	X	X	X	X
SHELL			X	X	X			
AQUATIC LIFE								

MUN: Municipal and domestic water supply.

AGR: Agricultural supply.

GWR: Ground water recharge.

REC1: Water contact recreation.

REC2: Non-Contact water recreation.

WILD: Wildlife habitat.

COLD: Cold fresh water habitat.

WARM: Warm fresh water habitat

MIGR: Migration of aquatic organisms.

SPWN: Spawning, reproduction, and/or early development.

BIOL: Preservation of biological habitats of special significance.

RARE: Rare, threatened, or endangered species

EST: Estuarine habitat

FRESH: Freshwater replenishment.

COMM: Commercial and sport fishing.

SHELL: Shellfish harvesting.

Note from Table 1.1 that the Salinas River (lower) [hereafter referred to as the Lower Salinas River] is not designated to support the REC-1 beneficial use downstream of Spreckles to the Lagoon. However, this body of water is upstream of the Lagoon and the Salinas River Estuary [hereafter referred to as the Estuary], which are designated to support the REC-1 use. Therefore, any pollutant entering the Lower Salinas River could be transported to the Lagoon and Estuary. *Consequently, in order to support the REC-1 beneficial use in the Lagoon and Estuary, it is necessary for the Lower Salinas River to support the REC-1 beneficial use.*

#### 1.4. Removal of the SHELL Beneficial Use

Staff is proposing the SHELL beneficial use be removed from the Lagoon, Estuary, and Tembladero Slough. The removal of this beneficial use is being proposed at the same time as this TMDL Project is being proposed for approval. Staff has found no evidence, historical or contemporary, of the shellfish harvesting beneficial use in the Lagoon, Estuary, or Tembladero Slough. A Use Attainability Analysis is provided in Appendix A

of this Report, providing the basis of staff's proposal to remove the SHELL beneficial use.

## **1.5. Existing Water Quality Objectives**

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The Central Coast Region's Water Quality Control Plan (Basin Plan) contains specific water quality objectives that apply to indicator bacteria (CCRWQCB, 1994, pg. III-3). These objectives are linked to specific beneficial uses and include:

### Shellfish Harvesting (SHELL):

At all areas where shellfish may be harvested for human consumption, the median **total coliform** concentration throughout the water column for any 30-day period shall not exceed 70/100 ml, nor shall more than 10% of the samples collected during any 30-day period exceed 230/100 ml for a five-tube decimal dilution test or 330/100 ml when a three-tube decimal dilution test is used.

### Water Contact Recreation (REC-1):

**Fecal coliform** concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 per 100ml, nor shall more than 10% of total samples during any 30-day period exceed 400 per 100ml.

### Non-Contact Water Recreation (REC-2):

**Fecal coliform** concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 2000 per 100ml, nor shall more than 10% of samples collected during any 30-day period exceed 4000 per 100ml.

### Toxicity:

The Basin Plan identifies a general objective applicable to all waters. The objective states:

“All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board.”

This general objective applies to substances, including biotic, that are toxic to humans.

### Controllable Water Quality conditions.

Controllable water quality must conform to the water quality objectives stated in the Basin Plan. The Basin Plan defines controllable water quality conditions as:

“Controllable water quality conditions are those actions or circumstances resulting from man's activities that may influence the quality of the waters of the State and that may be reasonably controlled.”

## 1.6. Revision of Water Quality Objectives

The State Water Resources Control Board (State Board) is considering revision of State recommended water quality objectives for indicator bacteria. Currently, fecal coliform are used as indicators at levels discussed in the previous section. The State Board is considering a revision to incorporate the use of *E. coli* as indicator bacteria at levels recommended by USEPA. Water Board staff will monitor the progress of the State Board effort and, if necessary, will adjust the numeric targets of this TMDL before finalization. The numeric targets for this TMDL are discussed in Section 6 of this report.

The USEPA recommended levels for *E. coli* are discussed in the following section.

## 1.7. Water Quality Criteria

The United States Environmental Protection Agency (USEPA) periodically updates and publishes water quality criteria recommendations. Table 1-2 summarizes USEPA recommended bacterial water quality criteria for the protection of aquatic and human health.

**Table 1-2 USEPA recommended criteria for *E. coli*.**

Indicator	Risk Level	Geometric Mean Density (per 100 mL)	Single Sample Maximum Allowable Density (per 100 mL) <sup>a</sup>			
			Designated Beach Area (75 <sup>th</sup> percentile)	Moderate Full Body Contact Recreation (82 <sup>nd</sup> percentile)	Lightly Used Full Body Contact Recreation (90 <sup>th</sup> percentile)	Infrequently Used Full Body Contact Recreation (95 <sup>th</sup> percentile)
<i>E. coli</i>	8	126 <sup>b</sup>	235	298	409	575

Source: U.S. EPA (1986).

a. Calculated using the following: single sample maximum = geometric mean \* 10<sup>^(confidence level factor \* log standard deviation)</sup>, where the confidence level factor is: 75%: 0.675; 82%: 0.935; 90%: 1.28; 95%: 1.65. The log standard deviation from EPA's epidemiological studies is 0.4 for fresh waters.

b. Calculated to nearest whole number using equation: geometric mean = antilog<sub>10</sub> [(risk level + 11.74) / 9.40].

Note that the USEPA water quality criteria are in terms of *E. coli*, whereas the Central Coast Water Board water quality objectives for bacteria are in terms of fecal coliform.

## 1.8. Exceedence of Water Quality Objectives and Criteria

Note from the discussion in Sections 1.5 and 1.7 that the most stringent water quality objectives and criteria are those protecting water contact recreation. Therefore, for the purpose of this Project, exceedence is defined as excursion of the either of the following:

*No more than 10% of total samples during any 30-day period shall exceed 400 fecal coliform per 100ml (this includes any single sample if that sample is the only sample in a 30-day period).*

*No single sample shall exceed 409 *E. coli* MPN/100mL.*

The water quality objective expressed in terms of fecal coliform is equivalent to the Basin Plan water quality objective for the protection for water contact recreation. The water quality criteria expressed in terms of *E. coli* is equivalent to the USEPA criteria for “lightly used” full body contact recreation.

USEPA does not designate specific water contact beneficial uses to the waterbodies in the Project area; each beneficial use is potential, leaving Water Board staff to determine the likelihood of each beneficial use.

Central Coast Water Board staff (staff) has conducted reconnaissance and monitoring activities for two years in the Project area. Staff has not witnessed any full body water contact recreation in any of the waterbodies addressed in this Project. However, it is possible that some water contact recreation is occurring, even if infrequent. “Exceedence,” therefore, is based on “lightly used” USEPA criteria for full body water contact in the Project area.

Staff compared existing water quality data to these objectives and criteria. Data for individual waterbodies are presented in Section 3.2.

All of the following bodies of water have exceedences of the Basin Plan water quality objective and/or USEPA recommended criteria protecting the water contact recreation beneficial use.

1. Lower Salinas River
2. Salinas River Lagoon (north) [Lagoon]
3. Old Salinas River Estuary (Estuary)
4. Tembladero Slough
5. Salinas Reclamation Canal
6. Gabilan Creek
7. Alisal Creek

*E. coli* O157:H7 have been identified as the pathogen causing illness due to ingestion of lettuce and spinach grown in the lower Salinas Valley; one death resulted from the outbreak. Monitoring and analysis conducted as part of this TMDL Project effort utilized laboratory methods designed to identify and isolate O157:H7 from water column samples. *E. coli* O157:H7 have been identified in water column samples from several monitoring sites in the Watershed.

Areas where O157:H7 have been identified include:

- Lower Salinas River
- Gabilan Creek
- Towne Creek (tributary to Gabilan Creek)
- Tembladero Slough
- Old Salinas River Estuary

All waters must be free of toxic substances that produce deleterious responses in humans and wildlife, as required by the general toxicity objective. As such, these waterbodies are not meeting the general toxicity objective due to the presence of *E. coli* O157:H7. In addition, the presence of *E. coli* O157:H7 is an indication of fecal contamination in surface these surface waters.

## **1.9. Problem Statement**

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The Basin Plan water quality objective and/or the USEPA criteria protecting water contact recreational use are exceeded in the following bodies of water:

1. Lower Salinas River
2. Salinas River Lagoon (north)
3. Old Salinas River Estuary
4. Tembladero Slough
5. Salinas Reclamation Canal
6. Gabilan Creek
7. Alisal Creek.

The general toxicity objective is exceeded by the presence of *E. coli* O157:H7, which is present in the following waterbodies:

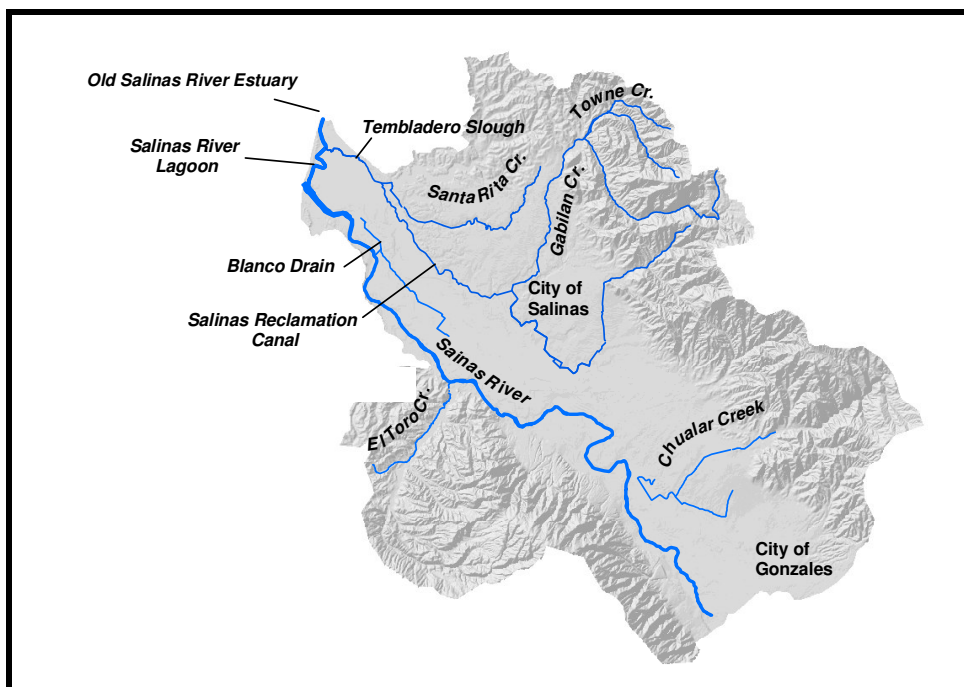
1. Lower Salinas River
2. Gabilan Creek
3. Towne Creek (tributary to Gabilan Creek)
4. Tembladero Slough
5. Old Salinas River Estuary

## 2. WATERSHED DESCRIPTION

The Lower Salinas River and its tributaries can be subdivided into two subwatersheds that in turn are divided into several subwatersheds. The Salinas River Lagoon and the Salinas River Estuary are the two receiving water bodies for tributary subwatersheds. Table 2-1 shows the subdivision into two main receiving water bodies and the tributaries to these receiving water bodies. Figure 2-1 illustrates the waterbodies and their connectivity.

**Table 2-1 Receiving waterbodies and tributaries of Project area.**

Receiving Water Body	
Salinas River Lagoon	Salinas River Estuary
<i>Subwatersheds to the receiving water bodies</i>	
Lower Salinas River	Tembaladero Slough
El Toro Creek	Gabilan Creek
Blanco Drain	Salinas Reclamation Canal
	Alisal Creek
	Chualar Creek



**Figure 2-1 Waterbodies in the Lower Salinas River**



## 2.1. Land Use

Land uses within the subwatersheds are estimated using National Land Cover Data (NLCD). The NLCD is provided by the Multi-Resolution Land Characteristics Consortium, which includes the United States Geological Survey (USGS), the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Forest Service (USFS), the National Atmospheric and Space Administration (NASA), and the Bureau of Land Management (BLM). The NLCD was derived from images taken by Landsat's Thematic Mapper sensor. The land use categories are aggregated based on a level II classification scheme of the NLCD. Relative land use contribution is shown in Table 2-2.

**Table 2-2 Land uses of project area.**

Land Use Type	Acres	Frequency (%)
Row Crops	77,875	29.7
Grassland/Herbaceous	62,514	23.8
Deciduous Shrubland	42,622	16.3
Evergreen Forest	25,327	9.7
Pasture/Hay	20,574	7.8
Mixed Forest	9,052	3.5
Low Intensity Residential	6,771	2.6
Bare Rock/Sand/Clay	4,512	1.7
Other Grasses (Urban/Rec; e.g. parks, lawns)	3,725	1.4
High Intensity Comm/Ind/Trans	3,270	1.2
High Intensity Residential	2,620	1
Deciduous Forest	1,971	0.8
Quarries/Strip Mines/Gravel Pits	444	0.2
Open Water	318	0.1
Emergent Herbaceous Wetlands	290	0.1
Other	101	0.1
<b>Total</b>	<b>261,986</b>	<b>100</b>

ESRI ArcMap was used to create a land use cover for the Project area. The land use cover is used in conjunction with other information and data in the data analysis. A map of the land use cover is illustrated in Figure 2-2.

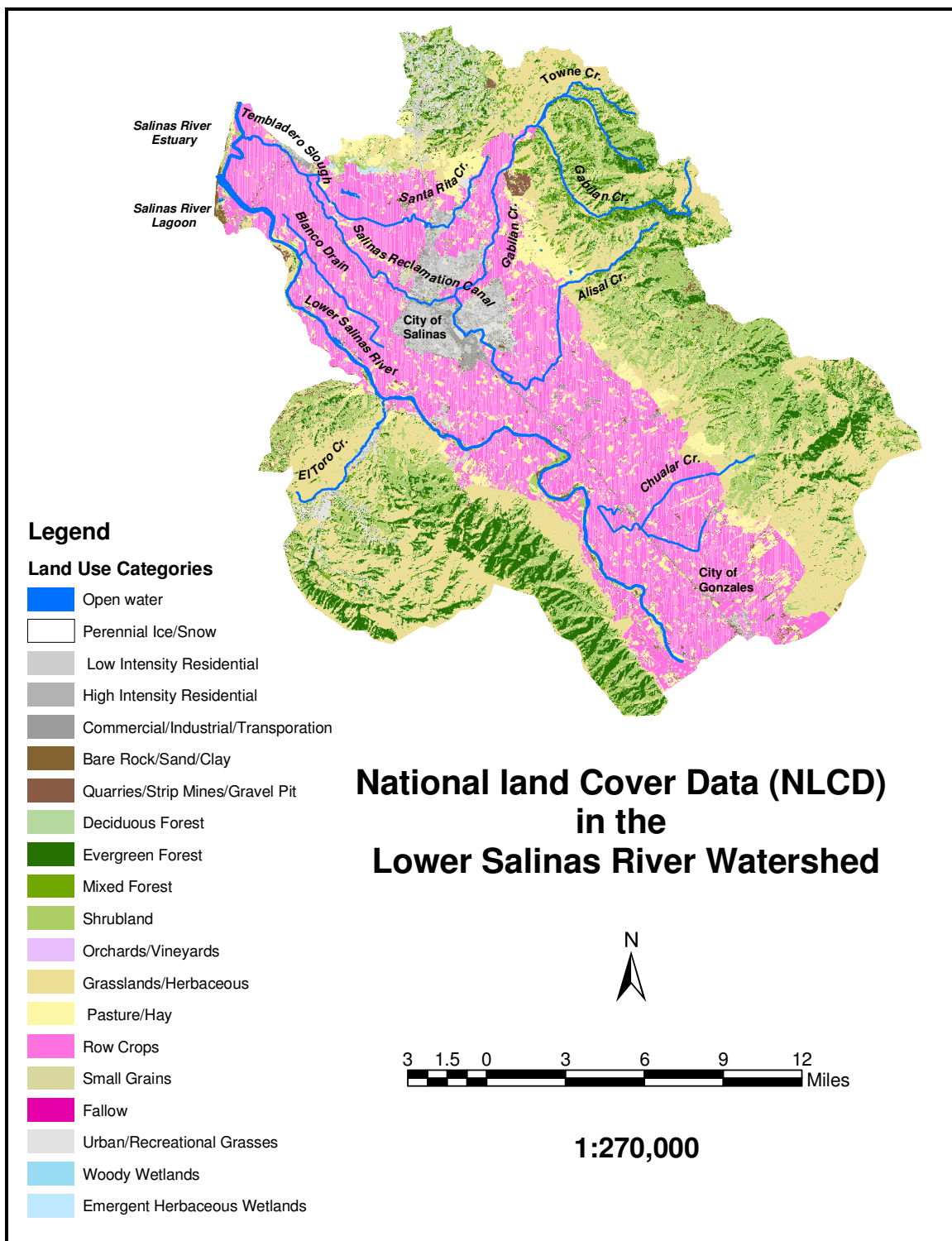
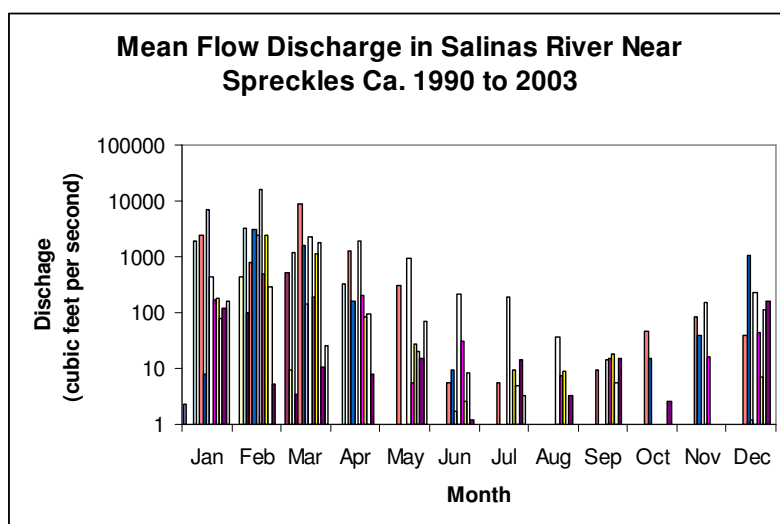


Figure 2-2 Land uses in the Project area.

## 2.2. Hydrology

The watershed area contributing to flow in the main stem of the Salinas River encompasses hundreds of square miles. Although much of the precipitation in the Salinas River Watershed is retained in reservoirs, flow reaches over 1000 cubic feet per second during the rain season in the lower portions of the watershed.

Sources of water in the surface waters include precipitation, releases from reservoirs, groundwater, and return flows from agricultural irrigation. Figure 2-3 illustrates mean flow in the Salinas River near Spreckles from 1990 to 2003. Note that the highest flows occur from January to March, indicating the influence of precipitation on mean flow.



**Figure 2-3 Discharge in Salinas River at Spreckles.**

Source: USGS gage station at Spreckles, CA.

Some of the surface waters in the watershed are perennial while some are ephemeral. The Lower Salinas River is dry during the late summer months upstream of Davis Road (near the City of Salinas). Alisal Creek is also dry during summer months. In contrast, the Salinas Reclamation Canal, Tembladero Slough, the Salinas River Lagoon, and the Old Salinas River Estuary are perennial; summer flows in these bodies of water are attributed to groundwater and irrigation sources.

Two impervious layers separate groundwater aquifers in the valley of the Watershed. The upper clay layer lies from ten to twenty feet below the surface. The upper clay layer restricts percolating water from entering the deeper aquifer, thereby causing movement of water between the upper groundwater and surface waters, e.g. the Salinas River and its tributaries. As such, groundwater sources to area water bodies are probable. However, it is probable that much of the water percolating downward through the soil profile during summer months originates from agricultural irrigation.

### **2.3. Climate**

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“Monterey County is favored with a generally mild climate. Temperatures near the coast are uniform throughout the year, but the range widens as distance from the water increases. At inland locations, summers are warm to hot and winters have minimum readings below freezing.

“The growing season is as short as 150 days in some mountain areas, but ranges from 200 days to more than 350 days in most areas where cultivated crops are grown.

“Precipitation is concentrated in winter. Totals range from about 10 inches in drier locations to near or slightly above 80 inches in the coastal mountains. Snowfall in the county is generally insignificant, although a limited amount is received each winter at the higher elevations.

“Abundant sunshine is characteristic of the inland area, but coastal areas and the coastal end of the Salinas Valley are subject to considerable cloudiness in summer. Much of this cloudiness, however, occurs during the night and morning hours.

“Winds are generally less than 10 to 15 miles per hour, though stronger winds are common to some areas along the coast. Winter storms produce some damaging winds, particularly in open areas and at higher elevations...

“The average annual temperature is about 55° F along the coast and in the mountains along the eastern boundary. Annual temperatures of about 60° F are characteristic of the interior valley.” (SCS, 1978)

### 3. DATA ANALYSIS

#### 3.1. Introduction

Ambient water quality assessments of pathogens for this Project rely principally on analysis for the presence of fecal coliform, generic *E. coli*, and *E. coli* O157:H7 from grab samples. The total coliform group of bacteria is from the family *Enterobacteriaceae*, which includes over 40 genera of bacteria. The total coliform group includes bacteria of both fecal and non-fecal origin. Common habitats for the group include soil, groundwater, surface water, the intestinal tract of animals and humans, the surface of plants, algal-mats in pristine streams, wastes from the wood industry, and biofilms within drinking water distribution systems (Hurst, et al., 2002). The total coliforms can be divided into various groups based on common characteristics. Among these, the fecal coliforms are generally indicative of fecal sources, though not all members of the group are of fecal origin (Hager, et al, 2004, p. 6). The bacteria species, *Escherichia coli*, comprises a large percentage of coliform detected in human and animal feces. Since sewage contains many types of disease-causing organisms, fecal coliform, including *Escherichia coli*, are often used as an indicators of pathogens.

Some strains of *Escherichia coli* (*E. coli*) are pathogenic and some are not. *E. coli* O157:H7 is one of the hundreds of strains of the bacterium *E. coli*. Animal sources of *E. coli* O157:H7 include both domestic and wild animals. Known sources include cattle (beef and dairy), horses, pigs, waterfowl, flies and dogs. Although most *E. coli* strains are harmless and reside naturally in the intestines of humans and animals, the *E. coli* O157:H7 strain produces a powerful toxin that can cause severe illness, even death. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination. Sewage may contain many types of disease-causing organisms; therefore, the presence of *E. coli* O157:H7 indicates not only that a pathogenic *E. coli* is present, but also indicates the potential presence of other pathogenic organisms.

Analysis of water samples to detect the *presence* of fecal coliform and *E. coli* (including O157:H7) is one way to determine the potential presence of pathogens. However, analytical methods for *quantifying* bacteria lack the precision common to many other laboratory methods for water quality analysis. For example, the Multiple Tube Fermentation (MTF) method results in an estimate of the most probable number (MPN) of bacteria. This number can vary considerably for a given result. For example, an MTF result of 1,600 MPN/100ml has a 95% confidence interval ranging from 600 to 5,300 MPN/100ml. The other common method, Membrane Filtration, also has limitations, particularly with highly turbid samples. The Colilert method also results in an MPN of total coliform as well as *E. coli*. The confidence interval is similar, and in some cases better, than the MTF method. Colilert has the advantage of being able to test for the presence of total coliform and *E. coli* in the same procedure and requires less time, relative to the MTF method.

*E. coli* O157:H7 can be identified using immunochemical and genetic methods. The methods used for isolating and identifying O157:H7 are more time-consuming and costly than the MTF and Colilert methods, but result in a positive identification of the bacterium. Polymerase chain reaction (PCR), culture, and Pathatrix methods for identifying *E. coli* O157:H7 were used for this project.

In spite of the limitations, testing for the presence fecal coliform, including *E. coli*, remains one of the best available methods for indication of potential fecal contamination (Ibid., p. 7), and therefore other pathogens. The MTF and Colilert methods, combined with methods of identifying the presence *E. coli* O157:H7, together provide strong indications of the presence and magnitude of pathogens, and therefore impairment of water quality.

### ***Bacterial Indicator Data***

The data used for this Project includes the two major groups including: 1) historic data, and 2) TMDL Project Data. The historic dataset is comprised of data collected by the Central Coast Water Board's Central Coast Ambient Monitoring Program (CCAMP). CCAMP is a regionally scaled effort aimed at gaining knowledge of water quality conditions over for many waterbodies and pollutants. The TMDL Project Data is water column data collected by staff specifically for this TMDL Project.

The CCAMP dataset used for this project ranges in time from February 1999 to August 2004. Grab samples were analyzed for fecal coliform density using the Multiple Tube Fermentation Method. A total of 192 data are used from 12 monitoring sites in the Project Area.

The TMDL Project dataset ranges in time from November 2004 to April 2006. Grab samples were analyzed for *E. coli* using the Colilert-18 or Colilert-24 method. Over 340 data were analyzed from 32 monitoring sites in the Project area.

Of the TMDL Project dataset, samples beginning in February 2005 were also analyzed for the presence of *E. coli* O157:H7 using two separate methods. Samples were analyzed for the presence of O157:H7 from 25 monitoring sites in the Project area using Pathatrix recovery as well as an immunomagnetic separation method (IMS). In addition, Moore swabs were placed in flowing waters for five days prior to collection and analysis at some monitoring sites and subsequently analyzed for the presence of *E. coli* O157:H7. There is a higher probability of detecting *E. coli* O157:H7 using Moore swabs, relative to grab samples, due to the extended length of time the swab is in the creek.

### ***Spatial Data***

Spatial data was prepared by Central Coast Water Board staff using Geographic Information Systems (GIS) software. GIS layers used include the National Hydrologic Data (NHD) for streams, California Watershed Map (CALWATER version 2.2) for watershed boundaries, Geographic Data Technology for roads (DGT roads), and National

Land Cover Data (NLCD) for land use. Staff also developed hillshade layers from digital elevation models (DEM) in the project area.

## 3.2. Water Quality Data

### ***Coliform Concentration***

Indicator bacteria data were gathered from the monitoring sites listed in Table 3-1. The table provides locations of monitoring sites as well as summary data for the CCAMP and TMDL datasets. This data will be discussed in more detail in the Section 4-Source Analysis. A map of the monitoring sites is provided in Figure 3-1. More detailed maps of subwatershed areas will be provided during discussion of these areas.

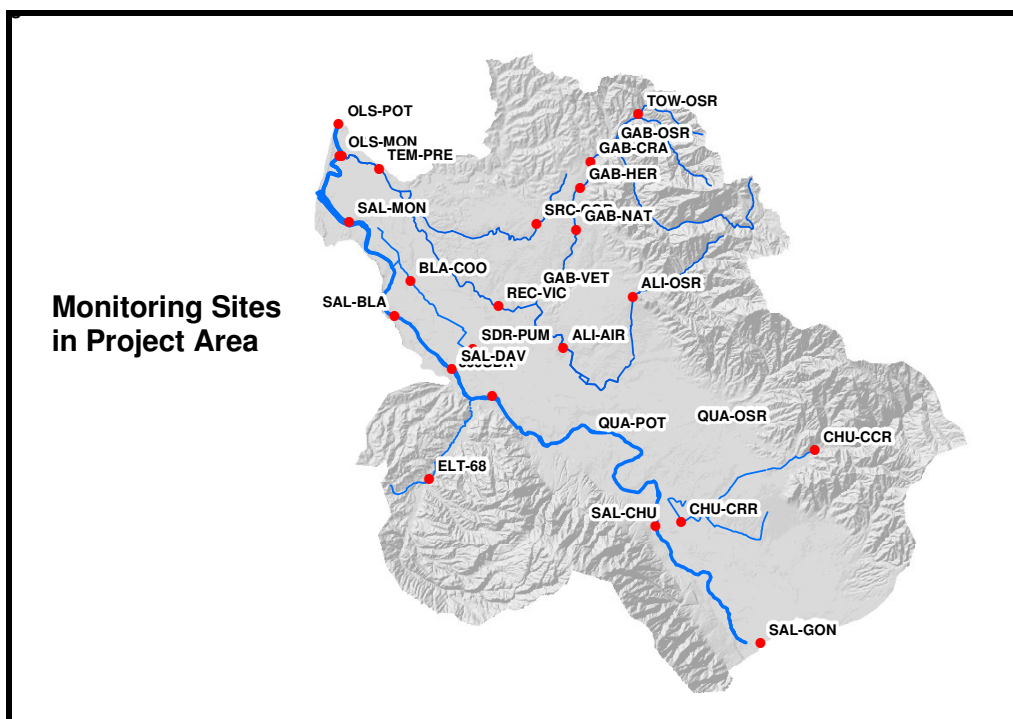


Figure 3-1 Map of monitoring site locations

**Table 3-1 Monitoring sites, locations, and summary data.**

Listed Waterbody?	Waterbody	Monitoring site	Location	Fecal Coliform					<i>E.coli</i>				
				minimum	maximum	average	median	geomean	minimum	maximum	average	median	geomean
303(d) Listed	Salinas River	(Gonzales to Spreckles)											
		SAL-GON	Salinas River at Gonzales Road						2	770	197	46	56
		SAL-CHU	Salinas River and Chualar River Road	2	900	136	40	38	10	2310	407	75	104
303(d) Listed	Salinas River	(Spreckles to Lagoon)											
		SAL-DAV	Salinas River at Davis Road	1	240000	6949	120	193	10	2700	547	63	133
		SAL-BLA	Salinas River at Blanco Road bridge						20	2419	324	97	131
303(d) Listed	Salinas River Lagoon (north)												
		SAL-MON	Salinas River at Monte Road	30	1300	292	150	151	1	2419	320	18	35
303(d) Listed	Old Salinas River Estuary												
		OLS-MON	Old Salinas River at Monterey Dunes Colony	23	92000	5795	495	740	85	2590	901	587	537
		OLS-POT	Old Salinas River at Potrero Road	26	54000	6218	240	342	20	2420	1289	1426	515
303(d) Listed	Tembladero Slough												
		TEM-PRE	Tembladero Slough at Preston Road in Castroville	30	2300	763	495	433	74	8820	1548	546	766
		TEM-MOL	Tembladero Slough at Molera Road	49	54000	4089	500	671	74	3360	1096	278	504
303(d) Listed	Salinas Reclamation Canal												
		REC-VIC	Salinas Reclamation Canal at Victor Way						76	3090	1335	910	810
303(d) Listed	Alisal Creek												
		ALI-OSR	Alisal Slough at Airport Road	2	17000	5267	4000	1264	980	980	980	980	980
		ALI-AIR	Alisal Creek at Old Stage Road	110	160001	50302	11000	10957	2	12590	1761	649	349



303(d) Listed	Gabilan Creek												
		GAB-OSR	Gabilan Creek at Old Stage Road						31	2419	622	326	356
		GAB-CRA	Gabilan Creek at Crazy Horse Road						201	6570	1269	512	769
		GAB-HER	Gabilan Creek and Herbert Road						35	6200	1566	770	778
		GAB-NAT	Gabilan Creek at Natividad Road						400	7590	2469	2419	1811
		GAB-VET	Gabilan Creek at the Veterans Park						4	5630	820	31	97
Not listed	Blanco Drain												
		BLA-COO	Blanco Drain on Cooper Road						20	1120	200	100	98
	Stormwater Drain to Salinas River												
		SDR-PUM	Storm drain pump off Hitchcock Road						100	14550	2252	1300	1015
Not listed	Santa Rita Creek												
		SRC-COR	Santa Rita Creek at Cornwall Street						30	3270	978	308	398
Not listed	Towne Creek												
		TOW-OSR	Towne Creek at Old Stage Road						291	4870	1402	754	984
Not listed	Arroyo Seco River												
		ARR-GOR	Arroyo Seco Creek at Gorge upstream of camp area						4	15	10	10	9

Note from Table 3-1 that all waterbodies exceed the either the 400 fecal coliform MPN/100mL or 409 *E. coli* MPN/100mL levels discussed in Section 1.8.

### 3.3. Land Use

Figure 3-2 shows the maximum density of *E. coli* against a land use map.

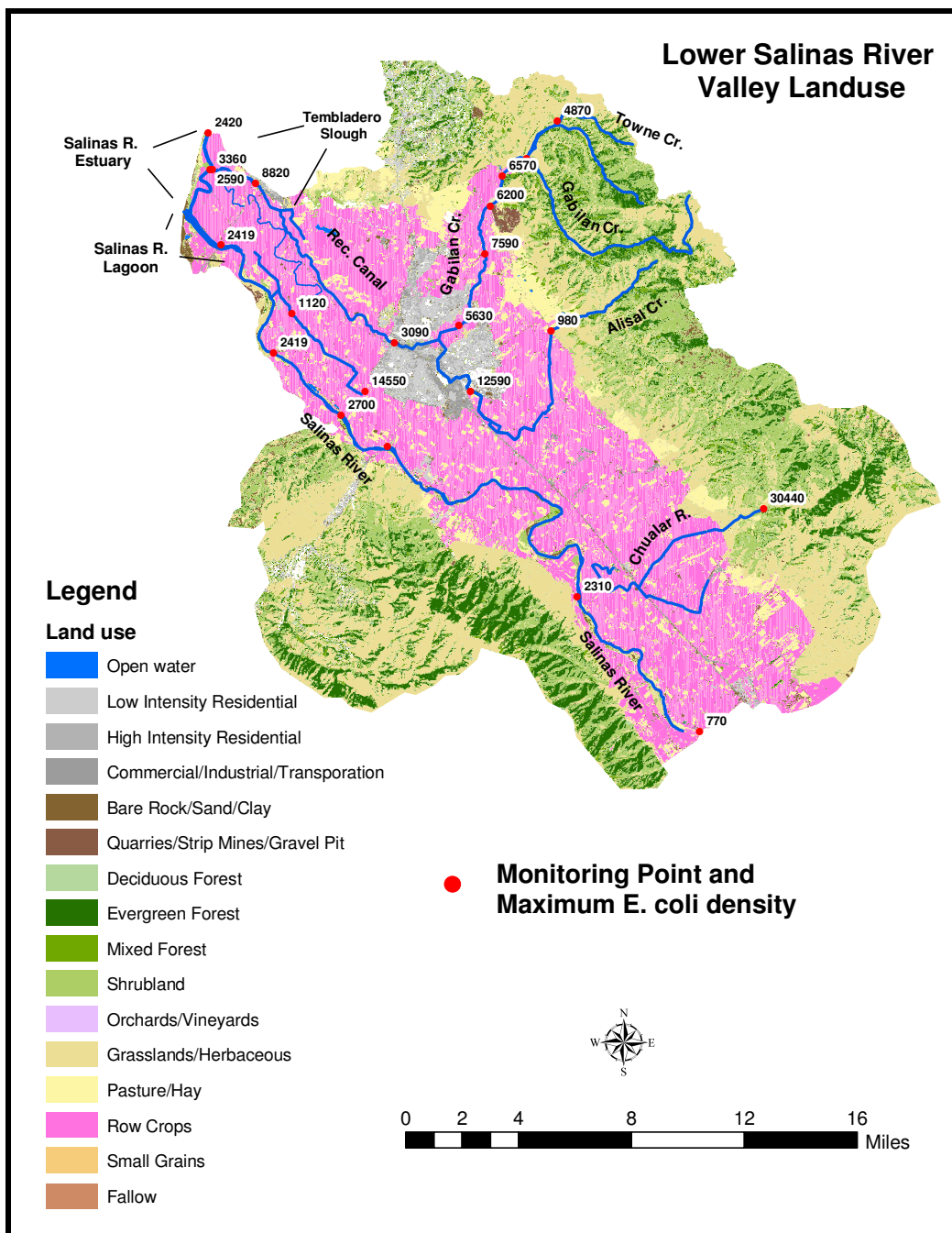


Figure 3-2 Maximum *E. coli* density and land use.

The following observations can be made from Figure 3-2.

1. Row crops are the dominant land use in the project area.
2. There is a general trend of increasing density in downstream reaches of the Salinas River and Gabilan Creek.
3. The highest densities are seen along Chualar Creek (30,440 MPN/100mL), draining pasture and naturally vegetated lands. The next highest densities (12,590 and 14,550 MPN/100mL) are seen at the urban/row crop interface.
4. All monitoring sites exceed the criteria discussed in Section 1.7.
5. Very few monitoring sites drain lands of a single land use.

The relationship between observed bacterial density and land use will be elaborated on in the Chapter-4, the Source Analysis section.

### **3.4. Flow Data**

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Flow data was not collected as part of this Project. Flow in the Salinas River can reach thousands of cubic feet per second (see Figure 2-3), rendering flow data collection for each sampling event beyond the resources of the Project. In addition, the TMDL and allocations are described in terms of bacterial density, and not load. Flow data is, therefore, not necessary for TMDL and allocation calculations.

### **3.5. Rain Events**

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Staff collected samples from thirteen sites during and after two separate rain events. Neither of the rain events were “first flush” events, but rather occurred latter in the rain season. Figure 3-3 illustrates *E. coli* density during rain and non-rain sampling. The darker bars denote rain event sampling densities and hollow bars denote non-rain sampling. Note that the y-axis is log-scale, with non-rain event sampling often being an order of magnitude lower than rain event sampling.

The median *E. coli* density during rain events was 2,685 MPN/100mL, whereas the median density during non-rain sampling was 223.5 MPN/100mL. Staff conducted statistical analysis of median densities using paired samples. Using the Mann-Whitney analysis, staff found that median density during rain events is statistically greater, compared to non-rain medians occurring shortly after rain events ( $p = 0.000$ ). The analysis is provided in the Appendix.

Sample locations drain a variety of land uses, and all sites, excepting one, had greater *E. coli* density during rain event sampling. There may be several factors driving *E. coli* density higher during rain events. Potential factors include:

- Bacterial loading from surface runoff throughout the watershed.
- Entrainment of bacteria on soil particles and alluvium.

A more detailed analysis of how rain events are affecting *E. coli* density in the watershed is provided in Chapter-4, Source Analysis.

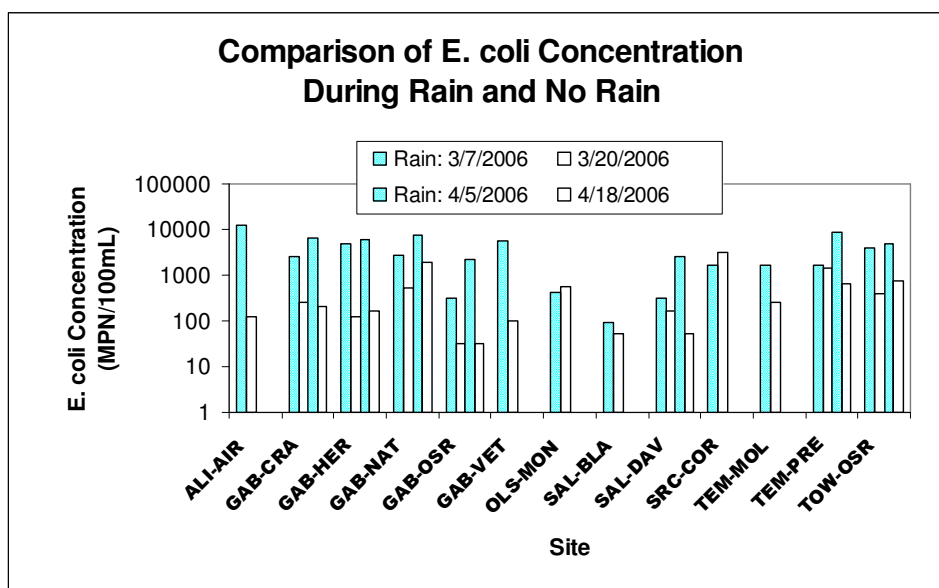


Figure 3-3 Comparing *E. coli* density during rain and non-rain event sampling.

### 3.6. Seasonal Indicator Bacteria Fluctuation

Section 3.5 discusses *E. coli* density differences during rain and non-rain event sampling. Another trend, perhaps in part related to rain event bacterial density, is seasonal fluctuation. There is a general trend of higher indicator bacteria (fecal coliform and *E. coli*) density during the rain season, relative to the drier summer months. In addition, there is a trend of increasing density during the summer, after a significant reduction in April and May after the rain season.

Figure 3-4 illustrates the monthly medians of the combined fecal coliform (CCAMP) dataset and *E. coli* (TMDL) dataset. Note the general trends of higher density in winter, as well as increasing density further into summer. Both of these trends are apparent in the fecal coliform and *E. coli* datasets.

The trend of higher density during the winter months can be explained by:

- Larger watershed area contributing to surface flow in wet weather, relative to dry weather.
- Higher bacterial density during rain events affecting surface runoff and entrainment.
- Differing land use practices between wet and dry weather.

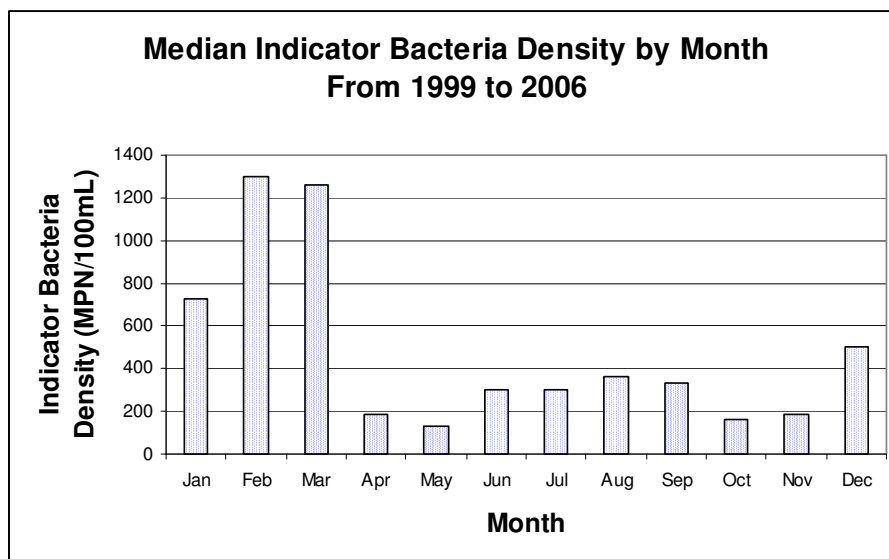


Figure 3-4 Combined *E. coli* and fecal coliform medians by month, from 1999 to 2006.

Most of the tributaries in the upper part of the watershed are dry during summer. Therefore, the trend of increasing density latter into the summer could be explained by increasing irrigation during drier months. This is difficult to prove, as there are few sites that strictly drain irrigated lands. Additionally, even if it can be demonstrated that irrigation practices are driving the increase in bacteria density during the summer months, the source organisms of indicator bacteria have not been identified; irrigation waters could simply be entraining bacteria residing in sediment that originated upstream of the irrigation.

Seasonal fluctuation will be investigated more in the Source Analysis Section.

### 3.7. Presence of *E. coli* O157:H7

*E. coli* O157:H7 (O157:H7) was discussed in the Introduction section of this chapter. Staff reviewed the occurrence of O157:H7 as an indication of potential sources of O157:H7 as well as other pathogenic organisms. Figure 3-5 below illustrates the number of samples at each site having a positive identification for O157:H7. Note from the map that O157:H7 first occurs in the headwaters of the watershed. A more thorough analysis is provided in Chapter-4, Source Analysis.

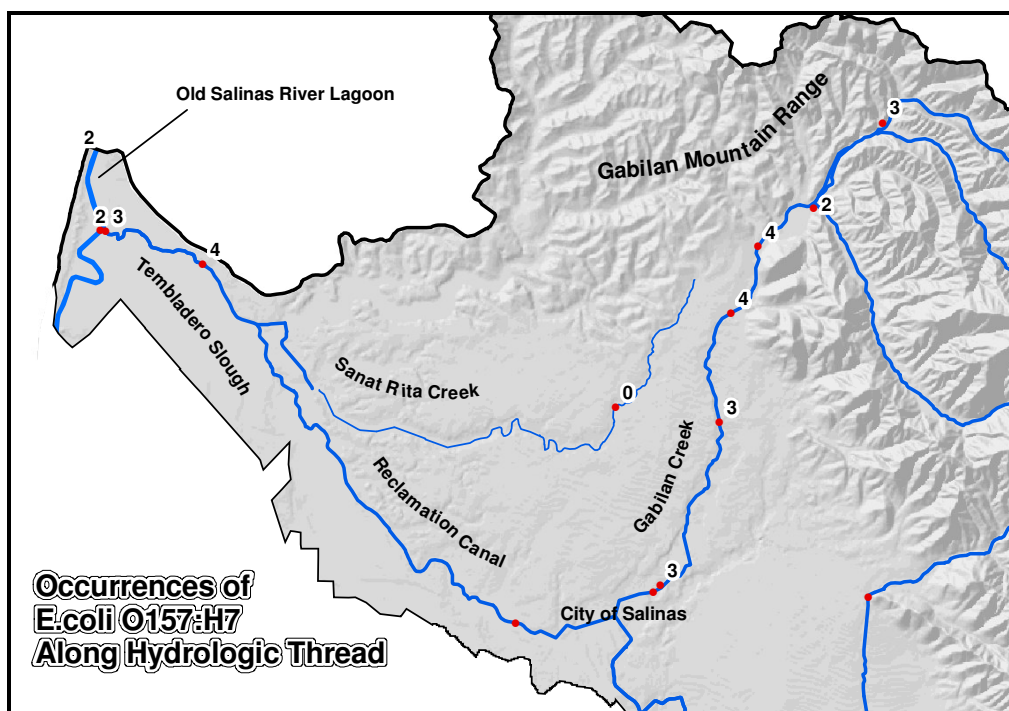


Figure 3-5 Frequency of *E. coli* O157:H7 from Gabilan Range and downstream.

### 3.8. Data Analysis Summary

The indicator organisms used for this Project include fecal coliform, generic *E. coli* and the *E. coli* strain O157:H7. “Exceedence,” for the purposes of this Project, is measured in terms of exceedence of existing water quality objectives and/or USEPA recommended criteria. For fecal coliform, a single sample exceeding 400 MPN/100mL is considered exceedence. For *E. coli* O157:H7, any presence is considered exceedence of the toxicity water quality objective. For generic *E. coli*, a single sample exceeding 409 MPN/100mL is considered exceedence.

All of the following waterbodies exceed either the water quality objectives for fecal coliform and *E. coli* O157:H7, or the USEPA recommended criteria for *E. coli*.

1. Salinas River (from Gonzales to Spreckles)
2. Salinas River (from Spreckles to the Lagoon)
3. Salinas River Lagoon
4. Old Salinas River Estuary
5. Tembladero Slough
6. Salinas Reclamation Canal
7. Alisal Creek
8. Gabilan Creek
9. Blanco Drain
10. Santa Rita Creek
11. Towne Creek

All of the waterbodies in bullets 1-11 above are on the 303(d) list as impaired due to fecal coliform, with the exception of the following:

1. Blanco Drain
2. Santa Rita Creek
3. Towne Creek

Although not individually 303(d) listed, each of these three waterbodies drain to a listed waterbody.

Land use descriptions are provided in Sections 2.1 and 3.3. The Salinas River watershed (Watershed) contains a variety of land uses. Row crops are the largest component of the land uses present. Staff has sampled surface waters from virtually all the land uses present in the watershed and have found exceedence of water quality objectives and criteria at nearly all sites draining various land uses. Only the Arroyo Seco River, at a monitoring station draining purely natural lands, carries *E. coli* density within the recommended criteria.

Rain events result in increased *E. coli* density in surface waters, relative to surface water flow during non-rain sampling. Indicator bacteria density also increases during the winter months, relative to spring and summer months. However, although the summer brings lower densities, the densities during these months exceed water quality objectives and criteria.

Staff has identified *E. coli* O157:H7 at several sites in the watershed, including headwater areas draining lands used for livestock grazing and naturally vegetated lands. The most frequent occurrence of *E. coli* O157:H7 occurs at sites flanking areas used for grazing purposes. This will be elaborated on in Chapter-4, Source Analysis.

## 4. SOURCE ANALYSIS

### 4.1. Approach

The data and information presented in Chapter-3 leads to the conclusion that sources of fecal coliform and *E. coli* (hereafter referred to collectively as indicator bacteria) are widespread both spatially and temporally. Exceedences of the water quality objectives and criteria cross over several land uses, subwatersheds, and seasons. In addition, there is a lack of pointed information that leads the analysis to a single, or even a few, major sources. Rather, the problem is widespread, and to some extent, consistent across the watershed.

Staff used the following approaches to identify *known* sources as well as a list of probable sources of indicator bacteria:

1. Investigation of identified sources of indicator bacteria.
2. Investigation of indicator bacteria increases at monitoring sites along a stream thread and their potential sources on a site-by-site basis.
3. Investigation of seasonal fluctuations of density.
4. Investigation of potential reasons for increases in density with the occurrence of rain events.
5. Investigation of consistently high and low indicator bacteria densities at individual monitoring sites.

### 4.2. Identified Sources

#### ***Livestock***

Livestock are common carriers of *E. coli* O157:H7. The United States Department of Agriculture, Agriculture Research Service (USDA ARS) estimates that as many as 100% of cattle lots could be infected with *E. coli* O157:H7 (AMI, 2004). A study of *E. coli* O157:H7 presence and persistence at county and state fairs in two states determined that 31 of the 32 fairs had livestock carrying *E. coli* O157:H7, with cattle having the greatest prevalence. In addition, *E. coli* O157:H7 persisted 10-11 months after the livestock were removed from the fairgrounds (Keen JE, *et al*, 2006). *E. coli* O157:H7 has also been isolated from the feces of, among others, horses, sheep, dogs, and deer (UW-M, 2006).

The presence of *E. coli* O157:H7 is a known pathogenic organism, but also indicates the presence of generic *E. coli* and other fecal coliform, both of which are used as indicator organisms of other pathogens. Beef and dairy cattle shed as many as  $1.0 \times 10^{11}$  fecal coliform each day (USEPA, 2001).



Staff began field reconnaissance of the Project area beginning in 2004. Staff has observed livestock access to riparian areas, including direct access to surface waters. The livestock observed include dairy cattle, beef cattle, and horses. In some areas, grazing has resulted in manure lining the banks of channels of tributaries to the Salinas River. Livestock accessibility is particularly evident in the upper reaches of Towne and Mudd Creeks, which are tributaries to Gabilan Creek. Monitoring sites in the Gabilan subwatershed, as well as monitoring sites downstream of this subwatershed, have tested positive for *E. coli* O157:H7.

Figure 4-1 illustrates the number of samples testing positive for *E. coli* O157:H7. Note that these areas are downstream from areas where livestock have access to the channel. Figure 4-2 illustrates livestock access to a wetland area near and draining to Gabilan Creek. The tributary flowing from the illustrated wetland area has a confluence with Gabilan Creek immediately upstream of monitoring site GAB-CRA.

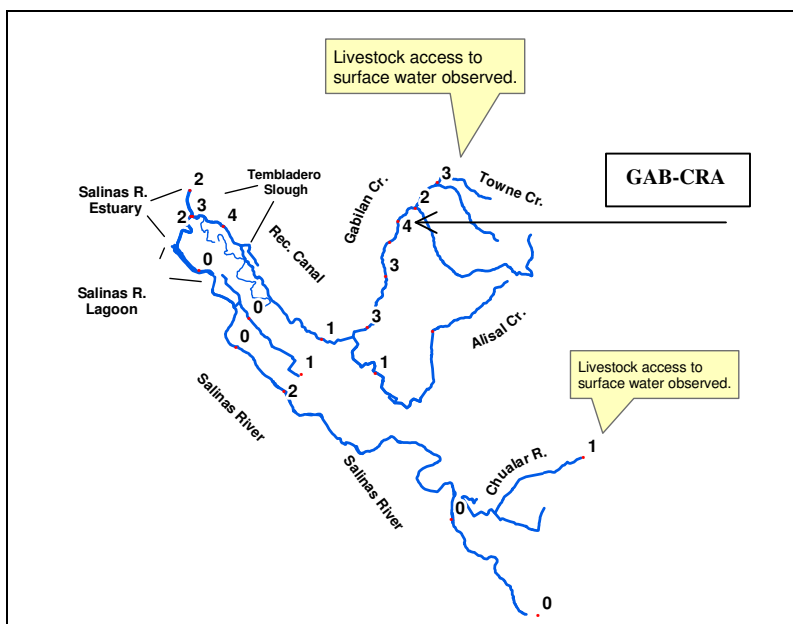
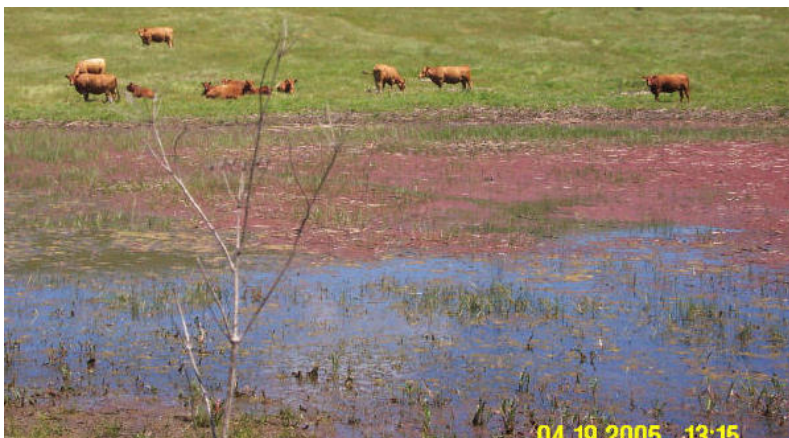


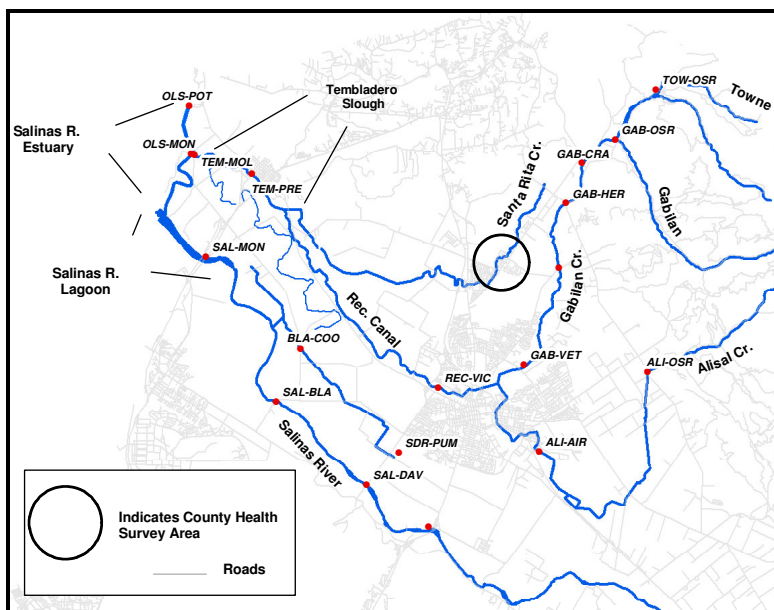
Figure 4-1 Number of samples testing positive for *E. coli* O157:H7.



**Figure 4-2 Livestock access to wetland area flowing to Gabilan Creek near GAB-CRA.**

It is important to note that although livestock are a known source of *E. coli* O157:H7, the samples testing positive for the *E. coli* O157:H7 in the Gabilan drainage could be from sources other than, or in addition to, livestock. However, what is certain is that livestock are a source of *E. coli*, including *E. coli* O157:H7, and fecal coliform in the Gabilan and Chualar Creek subwatersheds, and by hydrologic connectivity, to waters downstream of these drainages.

The Monterey County Department of Health (County Health) conducted a creek survey in April 2004 (field notes on file at Central Coast Water Board). County Health staff surveyed lands adjacent to Santa Rita Creek along a two-mile reach looking for sources of bacterial contamination. The area of the survey is illustrated in Figure 4-3.



**Figure 4-3 Creek survey area conducted by Monterey County Health Dept.**

Santa Rita Creek is a tributary to the Salinas Reclamation Canal and is located at the urban/rural lands interface. County Health staff found several sources of *E. coli* and fecal coliform sources, including:

1. Horses in Santa Rita Creek.
2. Cattle in the Santa Rita Creek.
3. Horse manure adjacent to the Santa Rita Creek.
4. Pigs adjacent to Santa Rita Creek.
5. Sheep adjacent to Santa Rita Creek.
6. Goat feces adjacent to Santa Rita Creek
7. Several drainpipes discharging to Santa Rita Creek.
8. Several solid waste sites adjacent to Santa Rita Creek.

The survey conducted by County Health staff included a fraction of the total stream length present in the watershed. Eighteen notices were sent to landowners who had potential or evident discharges to Santa Rita Creek. If the survey is a reflection of sources occurring throughout the watershed, then the number of indicator bacteria sources in the watershed reaches into the hundreds or tens of hundreds.

A TMDL project report has been drafted for the Watsonville Slough (on file at the Central Coast Water Board). Watsonville Slough is located approximately eight miles north of the northern edge of the Salinas River watershed. Genetic analysis was used to fingerprint sources of *E. coli* for the Watsonville project. The genetic analysis was undertaken by the laboratory group led by Dr. Betty Olson at the University of California at Irvine. They analyzed 16 samples using the Toxin Gene Biomarker method. This method involves extracting DNA from *E. coli* colonies grown on agar plates from water samples. The DNA is then analyzed for the presence or absence of toxin genes specific to a host animal. In the Watsonville study, toxin genes searched for included those for rabbit, human, dog, bird, and cow. There was a significant difference in *E. coli* density attributed to cattle during the wet season compared to the dry season; dry season was 2 MPN/100 mL, wet season was 5267 MPN/100mL. These results indicate that:

1. Cattle sources of *E. coli* alone exceed the water quality objectives in winter, discussed in Section 1.6.
2. Cattle sources of *E. coli* may be seasonal.

The seasonality of the livestock fraction is a reasonable finding because:

1. Grazing practices vary by season due to seasonal changes in forage.
2. Some surface waters flow seasonally and may coincide with increased grazing rotation.
3. Overland flow from terrestrial areas can transport *E. coli* from manure resting near surface waters.

Staff concludes that livestock are a source of indicator bacteria to surface waters in the Project area. The relative contribution of indicator bacteria by livestock is unknown. However, livestock are a known carrier of generic *E. coli*, *E. coli* O157:H7, and fecal coliform. Livestock have been observed roaming in surface waters as well as along

riparian areas in the Project area, and are therefore considered a source of indicator bacteria. Relative loading from the livestock source is probably seasonal, with the greatest contribution occurring during the wet season.

### **Urban Sources**

Many sources of fecal contamination are present in urbanized areas. Typical sources include:

- Domestic pets, including dogs and cats.
- Wild animals, including rodents, birds, and other small mammals.
- Feral dogs and cats.
- Humans

Urban sources of *E. coli* in areas along the central coast have been identified using DNA source tracking. Although DNA source tracking was not used for this Project, sources identified in areas adjacent to the Project area give a glimpse into the potential sources in the Project area. Identified sources of *E. coli* using DNA source tracking include (Draft Aptos Valencia Pathogen TMDL):

1. Birds
2. Dogs
3. Cats
4. Horses
5. Rodents
6. Human.

Staff has verified the domestic pet source (dog, cat) through personal communication with the City of Salinas. Wastewater crew for the city of Salinas has observed, on several occasions, citizens disposing pet waste into storm drains (personal communication, wastewater crew). In addition, staff has observed human fecal matter adjacent to surface waters within the City of Salinas.

Urban sources of fecal contamination make their way to surface waters through surface runoff as well as through storm sewer systems. There are numerous storm drain outlets to surface waters in the watershed. Surface waters receiving storm water in the watershed include, but are limited to:

- Lower Salinas River and all waters downstream (Estuary and Lagoon)
- Alisal Creek
- Salinas Reclamation Canal
- Tembladero Slough

All of these waterbodies receive flow from multiple sources, including urban stormwater. Therefore, it is difficult to quantify the contribution of urban sources to these waterbodies. However, monitoring site SDR-PUM is a storm drain pump station located in the city of Salinas. Water flowing to the pump station is purely stormwater, which is discharged to the Salinas River upstream of Davis Road. Review of data from this

monitoring site sheds light on the bacterial indicator density of storm water, and urban sources in general. Table 4-1 shows the complete dataset from site SDR-PUM. Summary data of site SDR-PUM can be seen in Table 3-1, and the location illustrated in Figure 3-1.

**Table 4-1 Stormwater data from monitoring site SDR-PUM.**

Monitoring Site	Monitoring Date	<i>E. coli</i> (MPN/100mL)
SDR-PUM	11/09/04	185
SDR-PUM	11/09/04	225
SDR-PUM	12/07/04	2,420
SDR-PUM	01/12/05	> 2,149
SDR-PUM	02/16/05	1,300
SDR-PUM	03/23/05	2,419
SDR-PUM	04/20/05	765
SDR-PUM	07/26/05	> 2,419
SDR-PUM	08/16/05	> 2,419
SDR-PUM	10/25/05	199
SDR-PUM	11/15/05	676
SDR-PUM	12/13/05	630
SDR-PUM	01/17/06	100
SDR-PUM	03/20/06	14,550
SDR-PUM	04/18/06	3,320
<b>Average</b>		<b>2,252</b>
<b>Maximum</b>		<b>14,550</b>

Note the maximum density of 14,550 MPN/100mL on March 20, 2006. This maximum density occurred during a rain event and is indicative of the transport of indicator bacteria from urban areas to receiving waters. Also note from Table 3-1 that monitoring site SDR-PUM has the highest recorded level of *E. coli*, and one of the highest maximum densities of indicator bacteria in the Watershed (see Figure 3-2).

Staff concludes that urban sources are a significant contributor of indicator bacteria to surface waters in the Project area.

The following entities have stormwater discharges that are currently, or expected to be, regulated with NPDES municipal stormwater permits.

1. Monterey Regional Group; this includes the urbanized areas of:
  - a. County of Monterey, including, but restricted to:
    - i. Castroville
    - ii. El Toro area
    - iii. Spreckles
2. City of Salinas

### ***Illegal Dumping***

Surface waters and riparian areas are commonly used for illegal dumping of domestic waste in the project area. Staff has documented domestic trash at many rural sampling sites.

The Monterey County Department of Health (County Health) conducted a creek survey in April 2004 (field notes on file at Central Coast Water Board). County Health staff noted and photographed eleven incidences of solid waste dumping along the two-mile reach investigated of Santa Rita Creek. Central Coast Water Board staff has also encountered numerous dumping sites along and in surface waters in the Watershed. On one occasion, staff observed soiled baby diapers dumped in Gabilan Creek.

The relative contribution of indicator bacteria from illegal dumping is not possible to calculate with the information available. However, the source is widespread and is a verified source.

### ***Non-permitted Discharges to Surface Waters***

Discharges to surface waters are permitted through the National Pollutant Discharge Elimination System (NPDES), which is administered (in the Project area) through the Central Coast Water Board.

As discussed in the above section, the County Health Department conducted a creek survey in April 2004 (field notes on file at Central Coast Water Board). Results of that survey included the discovery of eleven piped discharges to Santa Rita Creek in the two-mile reach investigated. (The County Health Department subsequently contacted property owners to cease the discharges). Most of the discharges were apparently domestic gray water. Some may be sewage discharges. The two-mile reach investigated is a fraction of the total lineal urban/rural-developed stream length of the watershed. It is highly probable that such non-permitted discharges exist in other areas of the watershed.

Non-permitted discharges are an identified source of indicator bacteria to surface waters of the Project area. The relative contribution of such discharges cannot be determined with the information available.

### ***Background Sources***

Numerous wild animals are present in the Project area and are potential sources of indicator bacteria to surface waters. The animals that are likely contributors of indicator bacteria to surface waters in the project area include skunk, opossum, raccoon, deer, geese, turkey, egret, heron, as well as others.

DNA analysis of fecal coliform and *E. coli* has been performed on samples drawn from surface waters near the Project area. Analysis of samples drawn from the nearby Aptos watershed, near Santa Cruz, California, yielded interesting results regarding background sources (on file at Central Coast Water Board). In the Aptos analysis, over 50% of the identified fecal coliform sources originated from wild animals, with birds being the most significant source. In Watsonville Slough, it is estimated that over 50% of the *E. coli* found in samples drawn during *summer* months originated from wild birds (analysis on file at Central Coast Water Board). These findings cannot be applied to the Salinas River watershed. However, it should be noted that background sources of fecal coliform and/or *E. coli* could, in some cases, may be a significant portion of the total source inputs, perhaps even exceeding the water quality objective during some seasons and some portions of the watershed.

The Arroyo Seco River is a tributary to the Salinas River. The Arroyo Seco has a confluence with the Salinas River approximately one mile upstream of the City of Gonzales. The headwaters of the Arroyo Seco contain minimally impacted areas that reflect background *E. coli* densities in the headwaters of the watershed; although background levels in the lower portions of the Salinas River watershed, e.g. near the mouth of the Salinas, may differ from the headwater areas.

Figure 4-4 illustrates the location of the Arroyo Seco monitoring site labeled ARR-GOR. Table 4-2 shows the *E. coli* density of the Arroyo Seco monitoring site, as well as the downstream monitoring site of the Salinas River at Gonzales, labeled SAL-GON. Note that the *E. coli* density at ARR-GOR is well below the water quality objectives described in Section 1.6, as well as well below the densities found in lower areas of the watershed as shown in Figure 3-2.

Staff concludes that background sources in the headwaters of the watershed are below 50 MPN/100mL during the wet months. Background sources in lower reaches, e.g. near the mouth of the Salinas River, are unknown.

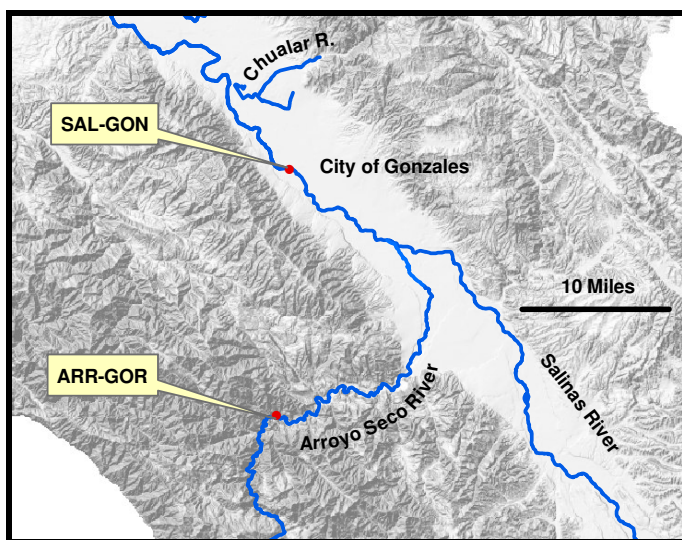


Figure 4-4 Location of Arroyo Seco River monitoring site for background *E. coli* density.

Table 4-2 Arroyo Seco and Salinas River at Gonzales *E. coli* data.

ARR-GOR	<i>E. coli</i> MPN/100mL	SAL-GON	<i>E. coli</i> MPN/100mL
04/11/06	4	04/11/06	No data
04/18/06	15	04/18/06	41
05/15/06	11	05/15/06	52

### 4.3. Sources to Subwatersheds

Attention now turns to sources of indicator bacteria on a subwatershed basis. Monitoring sites are located along the main stem of the Salinas River, as well as many of its tributaries.

Recall from Section 2.0 that the Salinas River Watershed has two primary receiving waters: 1) the Salinas River Lagoon (Lagoon), and 2) the Old Salinas River Estuary (Estuary). Figure 4-5 illustrates how the Salinas River Watershed is divided into two smaller subdrainages.

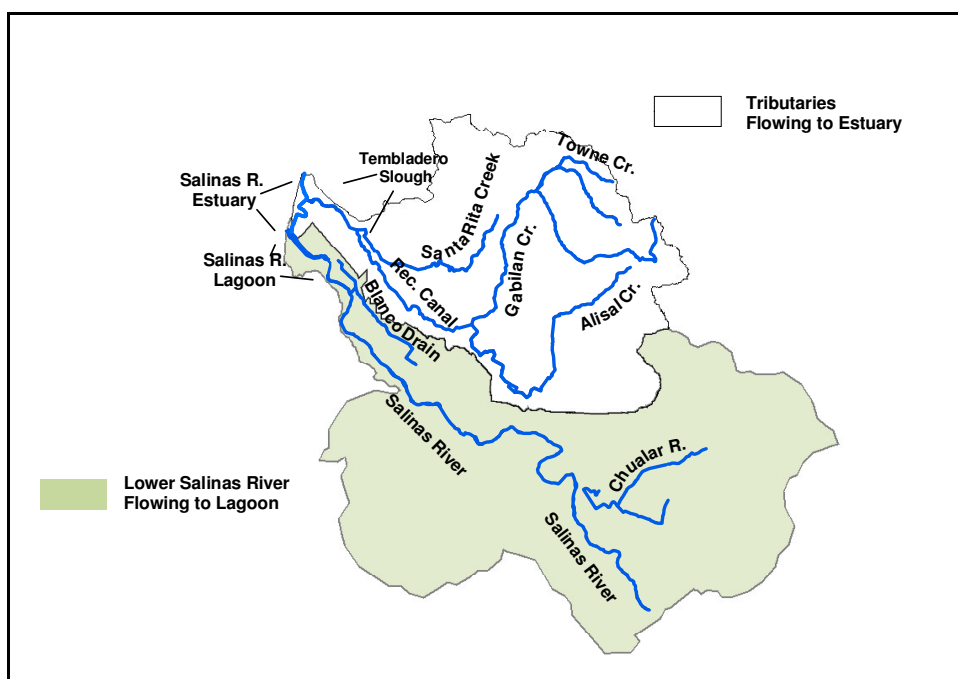


Figure 4-5 Salinas River Receiving Waters and Watersheds



Note that the Salinas River flows into the Salinas River Lagoon and the Tembladero Slough (and all the tributaries to it) flow into the Salinas River Estuary. However, the Lagoon also flows into the Estuary. Therefore, the Salinas River Estuary is the final receiving water body of the entire Project area.

Sources of indicator bacteria are now investigated on a subwatershed basis, and each of these contributions to its final receiving water body.

#### **4.4. Sources contributing to the Lower Salinas River Lagoon Watershed**

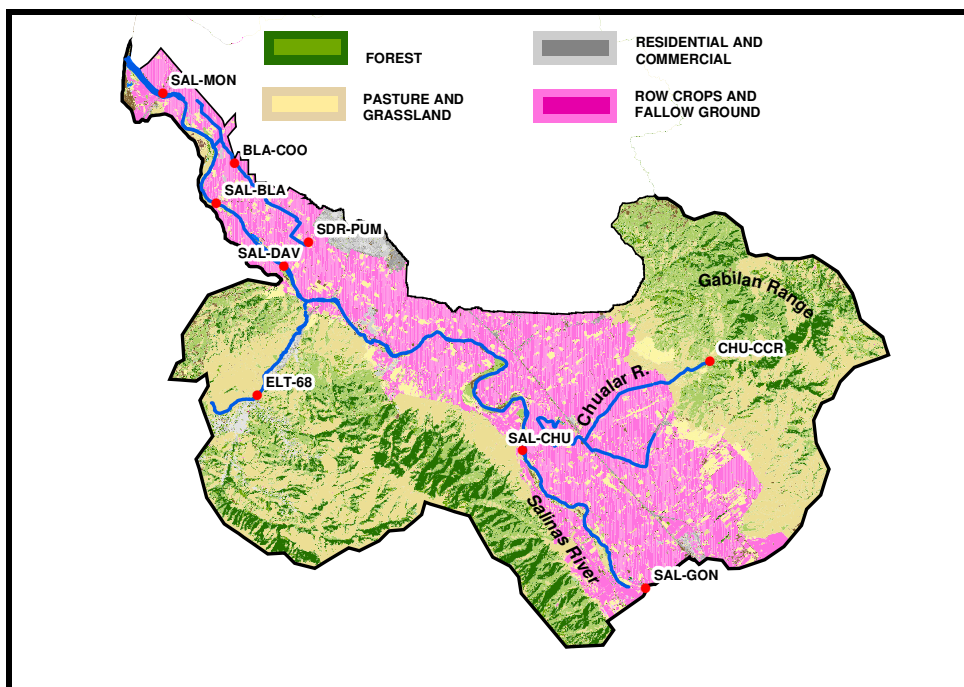
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The Salinas River Lagoon (Lagoon) has contributing flow from several sources, including:

1. Lower Salinas River (i.e., the Salinas River downstream of the City of Gonzales).
2. Chualar Creek: this flow is ephemeral and is largely dependent on significant rain events.
3. Storm Water: flow from a discharge pipe distributes storm water from the City of Salinas. The discharge pipe is located just north of monitoring site SAL-DAV. Flow from this source is seasonal and is dependent on rain events.
4. El Toro Creek: seasonal flow to the Salinas River.
5. Blanco Drain: flow originates almost exclusively from return flow from agricultural irrigation.
6. Watershed areas to the Lagoon and its tributaries.

Land uses in the Lagoon watershed includes row crops, pasture, grasslands, residential and commercial, and forest. Most of the forest, pasture, and grasslands do not contribute flow to the Salinas River during the summer months.

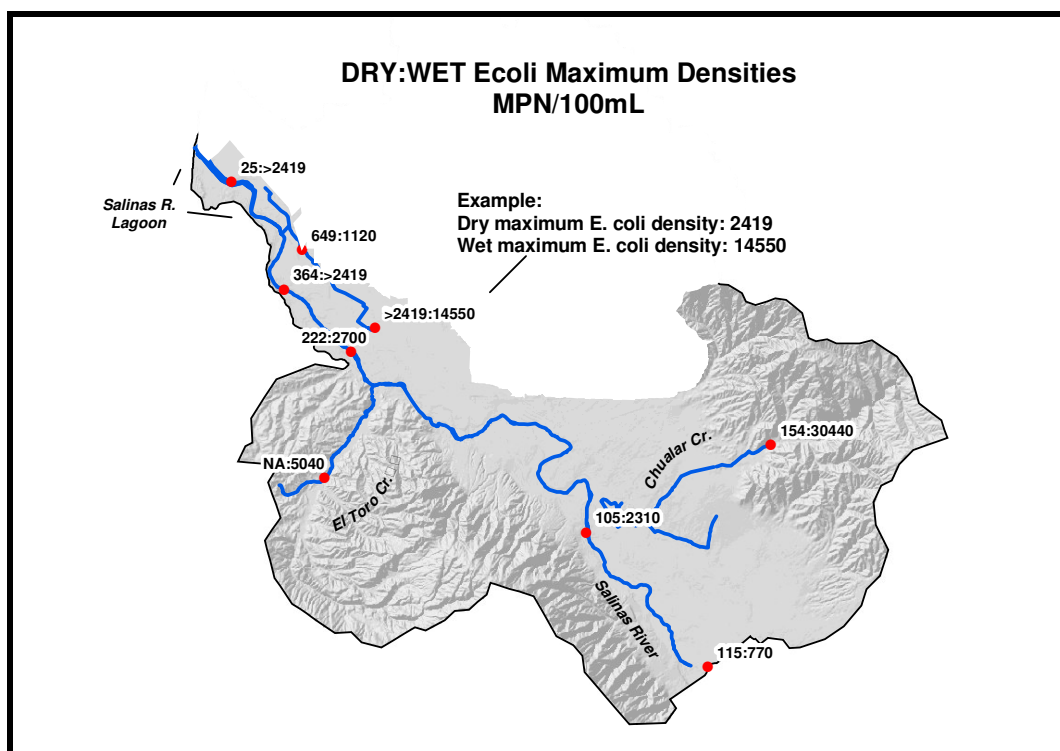
Figure 4-6 illustrates grouped land uses and monitoring sites in the Salinas River Lagoon watershed.



**Figure 4-6 Land uses and monitoring sites along the Lower Salinas River**

Monitoring site SAL-GON is the most upstream site and is along the Salinas River. Monitoring site SAL-MON is the most downstream site on the map. Note that the Salinas River is flanked by row croplands from SAL-GON downstream to the Lagoon. Forested lands, pasture, and grasslands contribute flow from tributary headwaters to the east and west of the Salinas River. However, most of the headwater areas are dry during late summer months, and therefore do not contribute indicator bacteria to the Salinas River during late summer.

Figure 4-7 illustrates the maximum wet and dry *E. coli* densities against the hillshade background of the watershed area contributing to the Salinas River Lagoon. Table 4-3 shows the exceedences of water quality objectives during the wet and dry months. Monitoring sites beginning with “SAL” refer to sites on the Salinas River. Wet months are considered from November through April, dry months are all other months.



**Figure 4-7 Maximum E. coli density during dry and wet months.**

SITE	DRY max			WET max		
	DRY max	Exceedence?	Exceedence?	WET max	Exceedence?	Exceedence?
	MPN/100mL	298 MPN/100mL <sup>1</sup>	409 MPN/100mL <sup>2</sup>	MPN/100mL	298 MPN/100mL	409 MPN/100mL
SAL-GON	115			770	X	X
CHU-CCR	154			30440	X	X
SAL-CHU	105			2310	X	X
ELT-68	No Data			5040	X	X
SAL-DAV	222			2700	X	X
SDR-PUM	2419	X	X	14550	X	X
SAL-BLA	364	X		2419	X	X
BLA-COO	649	X	X	1120	X	X
SAL-MON	25			2419	X	X

<sup>1</sup> USEPA recommended criteria for single sample protective of moderately used full body contact.

<sup>2</sup> USEPA recommended criteria for single sample protective of lightly used fully body contact.

**Table 4-3 Exceedences during wet and dry months in Salinas Lagoon watershed.**

Note from the map that all of the monitoring sites have higher *E. coli* density during wet months, relative to dry months. This pattern, as we will discuss, is seen throughout the Project area; wet weather indicator bacterial densities are higher than dry weather densities. Also note from the map the general trend of increasing density further downstream along the Salinas River. The trend of increasing density further downstream holds true for both wet and dry weather months.

Notice from Table 4-3 that all of the monitoring sites exceed both water quality objectives during wet months, but only three sites exceed the water quality objectives during dry months. Specifically, note that the only 'Salinas River' monitoring site exceedence is SAL-BLA during the dry months; all other dry weather exceedences are tributaries or, in the case of SDR-PUM, a pipe discharge. None of eighteen monitoring data from Salinas River monitoring sites exceed 409 MPN/100mL *E. coli* during dry months.

The fact that dry weather exceedence is zero percent, compared to 100% exceedence during wet weather, combined with the fact that the flow contributions from tributary and storm water sources are wet-weather dependent, leads to the possibility that indicator bacteria sources delivered from tributary and storm water sources may be largely responsible for the exceedences in the Salinas River during wet weather. This is so because indicator bacteria sources in the Salinas River during dry weather, i.e., when tributaries and stormwater sources are mostly dry, are not causing frequent exceedence. Furthermore, dry weather surface water sources in the Salinas River Lagoon watershed are highly dependent on agricultural return waters, which in turn, largely stem from ground water or recycled water, both of which typically carry low indicator bacteria density.

To further make this point, consider the data presented Table 4-4. Surface waters of Blanco Drain are nearly 100% irrigation return water, and therefore shed light on the agricultural return water contribution of indicator bacteria. Note from the table that during the combined dry and wet weather data, two exceedences of 409 MPN/100mL *E. coli* occurred. The infrequent exceedence of water quality criteria in Blanco Drain, during both wet and dry weather, relative to other sites that receive flow from multiple sources (e.g. along the Salinas River during wet weather), indicates that agricultural irrigation waters are not as significant contributors of indicator bacteria in the Salinas River between Gonzales and the Lagoon relative to other source waters.

Although agricultural return waters are not a significant contributor of indicator bacteria in the lower Salinas River, there may be portions of the Project area where land-applied manure is used to amend soil. Dairy operations are sometimes associated with land manure applications.

SITE NAME	DATETIME	ECOLI MPN/100mL	O157H7	Season	Exceedence of 298 MPN/100mL <sup>1</sup>	Exceedence of 409 MPN/100mL <sup>2</sup>
BLA-COO	20-Jun-05	649	0	DRY	x	x
BLA-COO	26-Jul-05	148	0	DRY		
BLA-COO	16-Aug-05	86	0	DRY		
BLA-COO	25-Oct-05	48	0	DRY		
BLA-COO	20-Apr-05	<b>299</b>	0	WET	x	
BLA-COO	15-Nov-05	20	0	WET		
BLA-COO	13-Dec-05	31	0	WET		
BLA-COO	04-Jan-06	120	0	WET		
BLA-COO	18-Apr-06	100	0	WET		
BLA-COO	09-Nov-04	29		WET		
BLA-COO	09-Nov-04	61		WET		
BLA-COO	07-Dec-04	1120		WET	x	x
BLA-COO	12-Jan-05	23		WET		
BLA-COO	16-Feb-05	137		WET		
BLA-COO	07-Mar-06	131		WET		

<sup>1</sup> USEPA recommended criteria for single sample protective of moderately used full body contact is 298 MPN/100mL.

<sup>2</sup> USEPA recommended criteria for single sample protective of lightly used fully body contact is 409 MPN/100mL.

**Table 4-4 E. coli density in agricultural return water.**

*The data and information indicate that sources of bacteria upstream and tributary to the Lower Salinas River and the Salinas River Lagoon are largely responsible for the 100% exceedence of water quality criteria during the rainy season (See Table 4-3). In addition, when tributaries, storm water, and upstream waters are dry, exceedence of water quality criteria in the Lower Salinas River and Lagoon is infrequent, relative to wet weather months. Attention, therefore, turns to wet weather sources of indicator bacteria to the Lower Salinas River and Salinas River Lagoon.*

The Salinas River extends for over 100 miles upstream of the SAL-GON monitoring site. Monitoring site SAL-GON receives upstream waters from hundreds of miles of tributary and main stem stream length and their watersheds. Sources of indicator bacteria during the wet season are numerous and ever changing with the land uses. Based on land use upstream of SAL-GON, likely source categories of indicator bacteria to SAL-GON include:

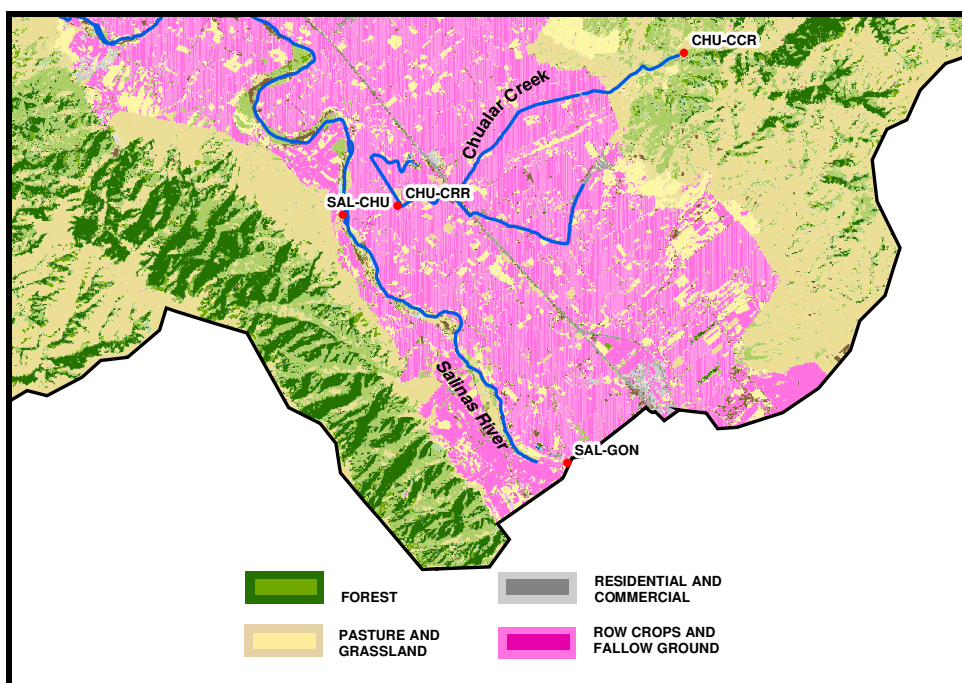
1. Background
2. Residential
3. Urban stormwater
4. Livestock
5. Land-applied manure

## Chualar Creek

Chualar Creek flows intermittently during and after rain events. Chualar begins in the headwaters of the Gabilan mountain range through natural lands, rural residential, light residential, then finally through irrigated croplands. Water from Chualar Creek mixes with agricultural return flows along the fertile valley floor near the town of Chualar before flowing into the Salinas River. Chualar Creek flows through lands used for grazing and equestrian in the Gabilan Range. Ranchettes are common along Chualar Creek Road, many providing riparian access to domestic farm animals. Monitoring site CHU-CCR is situated on Chualar Creek along Chualar Creek road, and is downstream of lands with livestock access to riparian areas. Table 4-5 and Figure 4-8 show data, monitoring sites, and adjacent land uses along Chualar Creek.

**Table 4-5 E. coli data for Chualar Creek sites.**

CCOWSCODE	Date	ECOLI	O157H7
CHU-CCR	04/05/06	30440	1
CHU-CRR	10/25/05	154	0
CHU-CRR	01/04/06	840	0
CHU-CRR	03/07/06	520	0
CHU-CRR	03/20/06	146	No data
CHU-CRR	04/05/06	6020	No data



**Figure 4-8 Monitoring sites on Chualar Creek and associated land use.**

Note from the table and figure above that CHU-CRR is downstream of CHU-CCR. Only one data point is available for CHU-CCR, with an *E. coli* density of 30,440. This sampling date occurred during a rain event. Notice that the highest *E. coli* density occurred on the same day at the downstream site CHU-CRR. Finally, note from the table that *E. coli* O157:H7 was present at site CHU-CCR. Recall from Section 3.1 that O157:H7 strain is often found in the feces of domestic livestock.

The evidence indicates that livestock are a source of indicator bacteria to Chualar Creek, although only intermittently during rain events. Chualar Creek, in turn, is part of a network of canals that receives both irrigation return water as well as storm water that eventually is discharged to the Salinas River.

### **Storm Water**

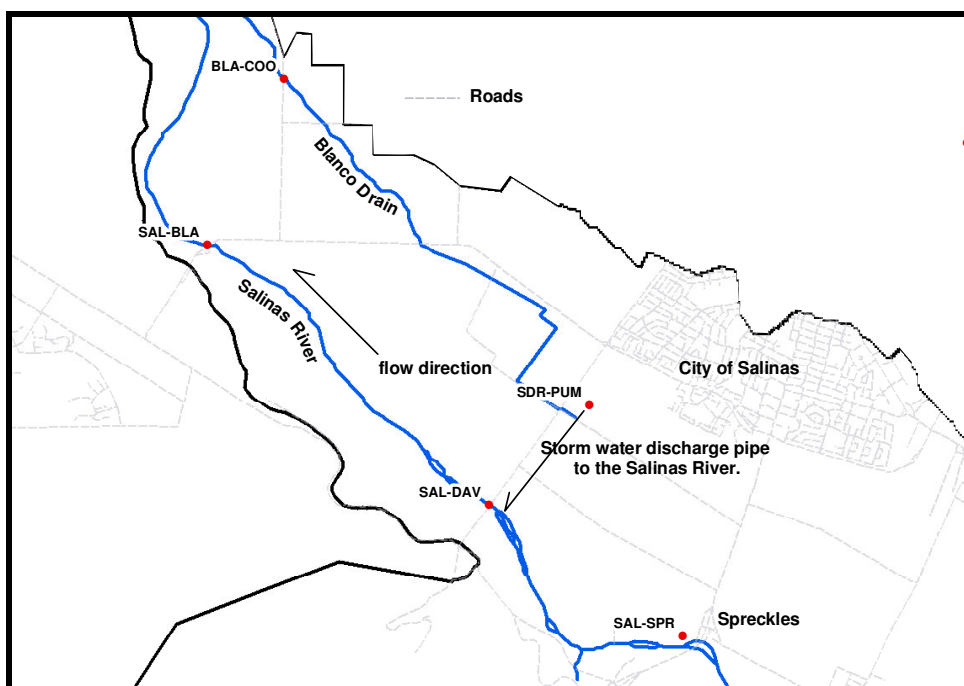
Monitoring site SDR-PUM is a storm water pump station located on the eastern edge of the City of Salinas (City). Samples drawn from the pump station are 100% urban stormwater from the City. The storm water is discharged to the Salinas River through a corrugated pipe located just upstream of monitoring site SAL-DAV. Table 4-6 shows the *E. coli* density during the wet months at site SDR-PUM. Figure 4-9 illustrates where the monitoring site SDR-PUM is located as well as the discharge point in the Salinas River.

Note from the figure that the discharge point is downstream of Spreckles. Recall from Section 1.3 that Spreckles marks the dividing point where downstream of this point full-body contact recreation is not expected.

Site	Date	<i>E.coli</i> MPN/100mL	Exceedence of 298 MPN/100mL	Exceedence of 409 MPN/100mL
SDR-PUM	09-Nov-04	185		
SDR-PUM	09-Nov-04	225		
SDR-PUM	07-Dec-04	2420	X	X
SDR-PUM	12-Jan-05	2149	X	X
SDR-PUM	16-Feb-05	1300	X	X
SDR-PUM	23-Mar-05	2419	X	X
SDR-PUM	20-Apr-05	765	X	X
SDR-PUM	15-Nov-05	676	X	X
SDR-PUM	13-Dec-05	630	X	X
SDR-PUM	17-Jan-06	100		
SDR-PUM	20-Mar-06	14550	X	X
SDR-PUM	18-Apr-06	3320	X	X

<sup>1</sup> USEPA recommended criteria for single sample protective of moderately used full body contact is 298 MPN/100mL.

<sup>2</sup> USEPA recommended criteria for single sample protective of lightly used fully body contact is 409 MPN/100mL.

**Table 4-6 *E. coli* density in storm water at site SDR-PUM.****Figure 4-9 Storm water discharge point along the Salinas River.**

The table above shows that urban storm water exceeds the USEPA recommended *E. coli* density. Although the storm water will probably not be used for this purpose, the data gives an indication of the levels present in storm water that are being discharged to the Salinas River.

The data and information lead to the conclusion that urban storm water carries levels of indicator bacteria above the USEPA recommended levels. Therefore, where storm water is discharged to a 303(d) listed surface water body in the Project area, it is considered a source of indicator bacteria causing impairment.

### ***El Toro Creek***

El Toro Creek is located on the eastern side of the watershed. Figure 4-10 illustrates the location of El Toro Creek and the surrounding land use. Note from the figure that El Toro Creek drains residential lands.

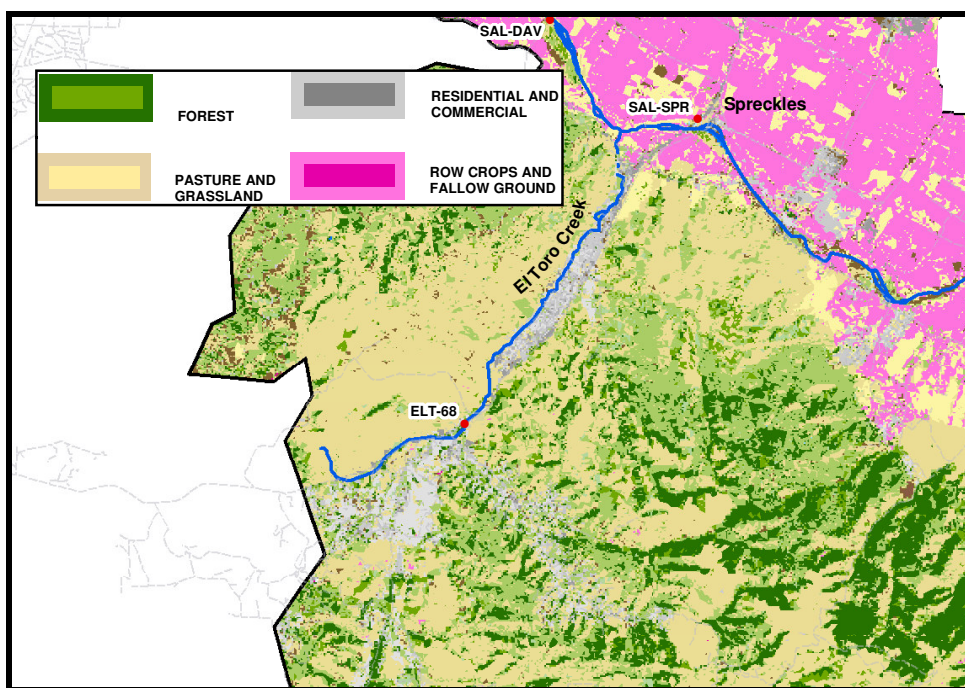
There are wet weather data points for El Toro Creek from site ELT-68. The data are shown in Table 4-7. Note that, like storm water from the City of Salinas, El Toro Creek discharges below the town of Spreckles. Also note from the table that the USEPA recommended criteria for *E. coli* is exceeded.



Monitoring Site	Date	E. coli MPN/100m L	Exceedence of 298 MPN/100mL	Exceedence of 409 MPN/100mL
ELT-68	05-Apr-06	5040	X	X
ELT-68	18-Apr-06	1610	X	X

**Table 4-7 Monitoring data from El Toro Creek.**

Probable sources of indicator bacteria in El Toro Creek include sources conveyed through storm water, as well as sources in the residential source category. It is possible that, like the Santa Rita Creek area, the El Toro urbanized area delivers bacterial sources from livestock, dumping, illegal point discharges, and other sources (see Section 4.2 for a detailed discussion of Santa Rita Creek). A more thorough on-site investigation is needed of the El Toro area to determine whether other sources are present.



**Figure 4-10 El Toro Creek and surrounding land use.**

## 4.5. Summary of Sources in the Lower Salinas River

Exceedence of water quality criteria for indicator bacteria area exceeded throughout the year in the lower Salinas River. However, exceedence of recommended bacterial levels are most often exceeded during wet weather months, and the exceedence is often orders of magnitude greater than the criteria.

Table 4-8 shows the land uses draining to the Lower Salinas River and the indicator bacteria commonly associated with those land uses.

**Table 4-8 Identified indicator bacteria and associated land use in the Lower Salinas River Watershed.**

Source	Land use
Human, pets, feral animals, leaking sewers, illicit connections.	Urban; Residential, Rural Residential, Commercial, Industrial
Livestock; including cattle, horses, goats, sheep, pigs, etc., faulty septic systems.	Pasture; Rural Residential
Livestock from land-applied manure.	Irrigated agriculture, Rural Residential
Uncontrollable sources, e.g. wildlife	All

Urban stormwater discharges indicator bacteria to surface waters in the lower Salinas River Watershed. Indicator bacteria sources delivered to the lower Salinas River from stormwater are most prevalent during wet weather months. Sources of indicator bacteria conveyed through stormwater include, but are not limited to:

- Human
- Pets; dogs, cats, bird, rodent, etc.
- Uncontrollable sources, e.g. wildlife.

Sources of indicator bacteria originating in headwater areas, e.g. Chualar and El Toro Creeks, include urban, livestock, and background sources. These watershed areas contribute indicator bacteria during the wet months of the year, particularly from November through April.

#### **4.6. Sources contributing to the Old Salinas River Estuary**

The Old Salinas River Estuary (Estuary) has contributing flow from the following surface waters and their tributaries:

1. Salinas River Lagoon and waters contributing to it.
2. Tembladero Slough
3. Santa Rita Creek
4. Salinas Reclamation Canal
5. Gabilan Creek
6. Alisal Creek

Figure 4-5 illustrates the portion of the larger lower Salinas River watershed contributing to the Estuary. Figure 4-11 illustrates the land use and monitoring sites in the contributing watersheds. Note that forest and grasslands dominate the northeastern portion of the watershed; some of the grassland areas, particularly along Gabilan Creek, are used for grazing purposes. In addition, there is the potential for land-applied manure in some locations. The northeastern portion of the watershed also contains rural residential areas. Sources of indicator bacteria from these land uses typically include:

- Livestock
- Land-applied manure
- Wildlife

The southwestern portion of the watershed is dominated by row crop agriculture, with the city of Salinas dividing the northern and southern areas. Sources of indicator bacteria from these land uses include:

- Domestic animals (pets and livestock)
- Feral dogs and cats
- Humans
- Wildlife

Figure 4-12 illustrates the wet and dry season maximum *E. coli* densities at the monitoring sites illustrated above. Note that the tendency of higher *E. coli* densities during wet months, like that of the watershed area contributing to the Lagoon, also occurs here. Also note that, like monitoring site ALI-OSR in the southeastern portion of the Project area (see Figure 4-6), maximum *E. coli* in areas flanked by forested and grassland areas (e.g. sites TOW-OSR, GAB-OSR) exceed USEPA recommended levels. This may seem counter-intuitive due to the relative “natural” setting. However, like the southwestern portion of the Project area, the northeastern portion natural areas have impacts from livestock grazing. This will be further discussed below.

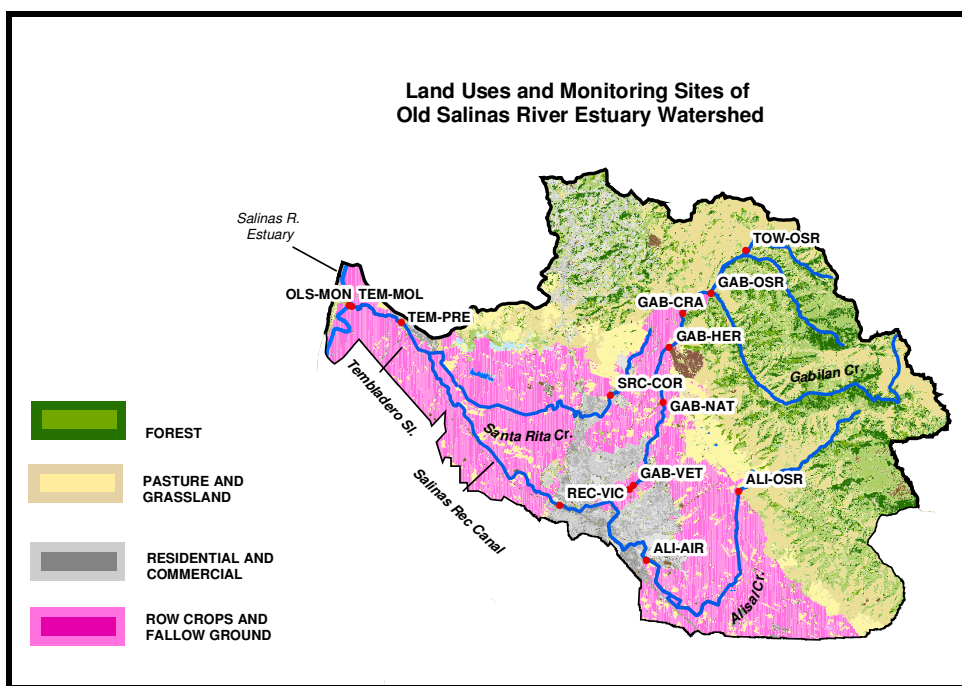


Figure 4-11 Land uses and monitoring sites of watersheds contributing to the Estuary.

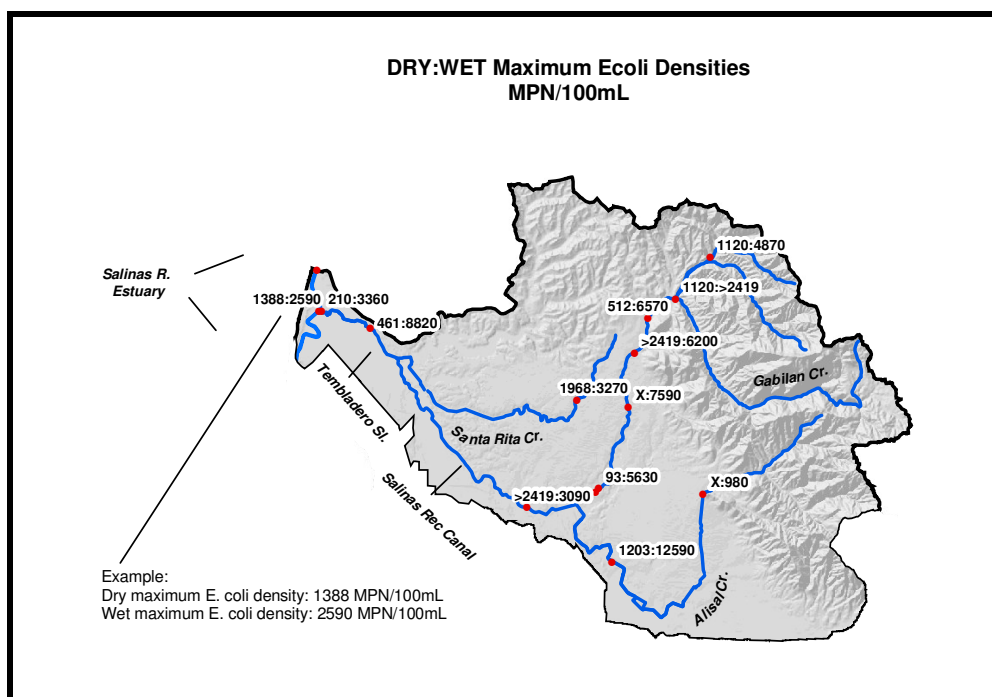


Figure 4-12 Maximum *E. coli* density during dry and wet months contributing to the Estuary.

SITE		DRY max			WET max	
	DRY max	Exceedence?	Exceedence?	WET max	Exceedence?	Exceedence?
	MPN/100mL	298 MPN/100mL <sup>1</sup>	409 MPN/100mL <sup>2</sup>	MPN/100mL	298 MPN/100mL	409 MPN/100mL
ALI-OSR	No data	No data	No data	980	X	X
ALI-AIR	1203	X	X	12,590	X	X
TOW-OSR	1120	X	X	4,870	X	X
GAB-OSR	1120	X	X	>2,419	X	X
GAB-CRA	512	X	X	6,570	X	X
GAB-HER	>2419	X	X	6,200	X	X
GAB-NAT	No data	No data	No data	7,590	X	X
GAB-VET	93			5,630	X	X
REC-VIC	>2419	X	X	3,090	X	X
SRC-COR	1968	X	X	3,270	X	X
TEM-PRE	461	X	X	8,820	X	X
TEM-MOL	210			3,360	X	X
OLS-MON	1388	X	X	2,590	X	X

Table 4-9 Exceedences during wet and dry months in Salinas Estuary watershed.

Note in Table 4-9 that *E. coli* densities are greater during winter months, relative to dry months. Recall that the same pattern occurred in the watershed area contributing to the Lagoon (see Table 4-3). Also note that all monitoring sites exceed USEPA

recommended density of *E. coli* during wet months; although some monitoring sites do not exceed recommended levels during dry months. Therefore, the following bodies of water, at some time, do not meet the recommended densities:

1. Alisal Creek
2. Gabilan Creek
3. Salinas Reclamation Canal
4. Tembladero Slough
5. Old Salinas River Lagoon

All of these bodies of water have the water contact recreation beneficial use designation (see Table 1-1) and should meet the criteria protecting this use.

### ***Alisal Creek***

The headwaters of Alisal Creek begin in the Gabilan mountain range on the east side of the watershed. The most downstream extreme end of Alisal Creek marks the beginning of the Salinas Reclamation Canal.

Natural flow in the headwaters Alisal Creek is ephemeral. Land uses in the upper portion of the Alisal Creek watershed include forest, pasture and grasslands, and spots of rural residential. Alisal Creek flows southwesterly from the Gabilan mountain range to the more flat Salinas valley floor, where row crops with irrigation is the dominant land use.

Monitoring site ALI-OSR is situated at the interface of the mountainous forested/pasture and row crop boundary; watershed area upstream of ALI-OSR drains forested/pasture areas and watershed area downstream of ALI-OSR drains row crop watershed area. Monitoring site ALI-AIR is downstream of ALI-OSR, and therefore receives flow contributions from lands draining row crops and residential areas. Site ALI-OSR also receives flow contributions from stormwater within the City of Salinas. Table 4-10 shows the monitoring data for Alisal Creek.

Note that there is only one *E. coli* data point for monitoring site ALI-OSR. This monitoring site is located in the ephemeral portion of Alisal Creek. Data from the older dataset of CCAMP, using fecal coliform as the indicator bacteria, is included at the bottom of the table. Monitoring site ALI-AIR, however, flows perennially because it receives discharges from upstream agriculture and urban sources. Table 4-10 shows that twelve of the seventeen data exceed a USEPA recommended level for *E. coli*. There is not enough dry weather data for a comparison of wet and dry weather data, however, it is apparent that exceedence of the USEPA recommended criteria occurs during both wet and dry months.

**Table 4-10 Monitoring data for Alisal Creek**

Site	Date	<i>E.coli</i> MPN/100mL	Exceedence of 298 MPN/100mL	Exceedence of 409 MPN/100mL
ALI-AIR	11/09/04	31		
ALI-AIR	12/07/04	1733	X	X
ALI-AIR	01/12/05	2420	X	X
ALI-AIR	02/16/05	2420	X	X
ALI-AIR	04/20/05	2		
ALI-AIR	06/20/05	649	X	X
ALI-AIR	07/26/05	435	X	X
ALI-AIR	08/16/05	1203	X	X
ALI-AIR	10/25/05	142		
ALI-AIR	11/15/05	20		
ALI-AIR	12/13/05	41		
ALI-AIR	01/04/06	2000	X	X
ALI-AIR	01/17/06	1450	X	X
ALI-AIR	03/07/06	12590	X	X
ALI-AIR	03/20/06	120		
ALI-AIR	04/18/06	4640	X	X
ALI-OSR	01/12/05	980	X	X
		Fecal Coliform MPN/100mL		
ALI-OSR	07/28/99	17000	X	X
ALI-OSR	08/31/99	5000	X	X
ALI-OSR	09/28/99	2		

Sources of indicator bacteria to monitoring site ALI-OSR include those from rural residential, pasture, and natural lands, including sources from:

- Livestock
- Wildlife

Sources of indicator bacteria to monitoring site ALI-AIR include those from ALI-OSR, as well as those from urban residential and row crop lands, including:

- Human
- Pets
- Feral animals
- Wildlife.

## **Gabilan Creek**

The headwaters of Gabilan Creek begin in the Gabilan mountain range northeast of Alisal Creek. Flow from Gabilan Creek flow into the Salinas Reclamation Canal within the City of Salinas.

Natural flows in headwater areas of Gabilan Creek were perennial during the data collection phase of the Project. One monitoring site, GAB-NAT, is dry during summer months; this may be due to irrigation well pumping upstream of this monitoring site. Land uses in the upper Gabilan Creek watershed are similar to those of upper Alisal Creek watershed, with pasture and grasslands dominating and some areas of rural residential. The upper Gabilan Creek watershed contains several subwatersheds with areas used for grazing purposes in the riparian areas. Cattle trails across and through creek channels are evident in some areas; livestock have complete access to wetted channels in several areas of the upper Gabilan. In addition, Water Board staff has observed a strong smell of manure during some months, indicating the potential of land-applied manure in the Gabilan subwatershed.

Several monitoring sites are situated along Gabilan Creek and its tributaries. The data for the Gabilan subwatershed are too numerous to list in the body of this document, but data is summarized below. Refer to Figure 4-11 for monitoring site locations.

Monitoring site TOW-OSR is along Towne Creek, which is a tributary to Gabilan Creek. The watershed area contributing flow to site TOW-OSR is dominated by forest, pasture, grassland, and some rural residential. Controllable sources of indicator bacteria to site TOW-OSR include:

- Livestock
- Wildlife

Recall from Figure 3-5 that *E. coli* O157:H7 have been observed during several monitoring events at site TOW-OSR and monitoring sites downstream of TOW-OSR. *E. coli* O157:H7 is observed more frequently during wet weather than in dry weather. Furthermore, the greatest number of O157:H7 identification occurred during the month of March. Water board staff has observed livestock access to the creek at TOW-OSR, as well as at areas upstream of this monitoring site. During one sampling event following a rain event, the genetic similarity of the identified *E. coli* O157:H7 at TOW-OSR and several sites downstream, including downstream monitoring sites in Tembladero Slough, indicate O157:H7 sources originate in the upper Gabilan system.

The prevalence of *E. coli* O157:H7 during wet months in the Gabilan system, and the fact that *E. coli* O157:H7 are prevalent in cattle, lead staff to conclude that livestock are a source of *E. coli* in Gabilan Creek and downstream receiving waters.

Table 4-11 shows summary data for the Gabilan Creek monitoring sites. Note the lack of consistency of *E. coli* density between sites in terms of both maximum and mean values. The inconsistency can possibly be explained by:

1. Varying number of samples (denoted by the symbol “n”)
2. Varying land use between monitoring sites
3. Confidence interval of the data value (see Section 3.1)
4. Flow and source contributions of tributaries and/or irrigation return water between monitoring sites.

The data indicate a clear exceedence of USEPA recommended density for *E. coli* in the Gabilan system, both in areas surrounded by grazing and natural areas (TOW-OSR), and areas surrounded by urbanized lands (GAB-VET).

**Table 4-11 Summary data for Gabilan Creek system.**

	E. coli	E. coli	E. coli	E. coli	E. coli	E. coli
	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL
→ → DOWNSTREAM → →						
Site/ data type	TOW-OSR	GAB-OSR	GAB-CRA	GAB-HER	GAB-NAT	GAB-VET
min	291	31	201	35	400	4
max	4870	2419	6570	6200	7590	5630
mean	1402	622	1269	1566	2469	820
median	754	326	512	770	2419	31
geomean	984	356	769	778	1811	97
n	17	17	17	17	9	22

Probable and verified sources of indicator bacteria in Gabilan Creek include:

1. Livestock
2. Pets
3. Feral animals
4. Humans
5. Land-applied manure
6. Wildlife

### ***Santa Rita Creek***

Santa Rita Creek is located northeast of Gabilan Creek. Flows in Santa Rita Creek were perennial during the data collection phase of the Project. However, flows during dry months could be the result of irrigation return waters. Irrigated row crops dominate land use in Santa Rita Creek subwatershed. In addition, Santa Rita Creek flows through the northeast portion of the City of Salinas. It is in the latter portion that the Monterey County Health Department conducted a two-mile investigation of Santa Rita Creek (see Figure 4-3). Please refer to Section 4.2 for discussion of the identified sources in the Santa Rita Creek subwatershed. The sources identified include:

1. Horses in Santa Rita Creek.



2. Cattle in the Santa Rita Creek.
3. Horse manure adjacent to the Santa Rita Creek.
4. Pigs adjacent to Santa Rita Creek.
5. Sheep adjacent to Santa Rita Creek.
6. Goat feces adjacent to Santa Rita Creek
7. Several drainpipes discharging to Santa Rita Creek.
8. Several solid waste sites adjacent to Santa Rita Creek.

One sampling location is located along Santa Rita Creek. Monitoring site SRC-COR is located at the urban/row-crop land use interface. Therefore, the monitoring site receives flows and sources predominantly from agricultural and urban lands.

Site	Date	<i>E.coli</i> MPN/100mL	Exceedence of 298 MPN/100mL	Exceedence of 409 MPN/100mL
SRC-COR	06/20/05	1732	X	X
SRC-COR	07/26/05	51		
SRC-COR	08/16/05	1968	X	X
SRC-COR	10/25/05	30		
SRC-COR	11/15/05	206		
SRC-COR	12/13/05	201		
SRC-COR	01/17/06	410	X	X
SRC-COR	03/07/06	1710	X	X
SRC-COR	03/20/06	3270	X	X
SRC-COR	04/18/06	200		

Note that 50% of the data exceed the USEPA recommended level of *E. coli*. The highest *E. coli* density of 3270 MPN/100mL occurred during a rain event on March 20, 2006.

Santa Rita Creek flows into the Salinas Reclamation Canal.

### ***Salinas Reclamation Canal***

The Salinas Reclamation Canal (Reclamation Canal) is a trapezoidal, channelized, perennial waterbody receiving flow from Alisal Creek, Gabilan Creek, Santa Rita Creek, numerous storm water discharge points, and several point discharges. The Reclamation Canal is contiguous with Alisal Creek and Tembladero Slough; Alisal Creek is contiguous and upstream of the Reclamation Canal, Tembladero Slough is contiguous and downstream of the Reclamation Canal. Figure 4-13 illustrates the Reclamation Canal in the City of Salinas. Notice the channelized trapezoidal channel, as well as the storm water discharge pipe.



**Figure 4-13 Salinas Reclamation Canal in the City of Salinas**

Irrigated row crops and urbanized lands dominate land uses contributing flow and sources of indicator bacteria to the Reclamation Canal. Recall, however, recall that watershed area from the Gabilan and Alisal Creek systems also contribute flow and indicator bacteria to the Reclamation Canal

Monitoring site REC-VIC is located in the City of Salinas. *E. coli* data were gathered from this site. Monitoring site ALI-AIR is upstream of REC-VIC, and site GAB-VET is from Gabilan Creek before its confluence with the Reclamation Canal. Paired data (the same number of data collected at the same time) from these three sites are compared in Figure 4-14.

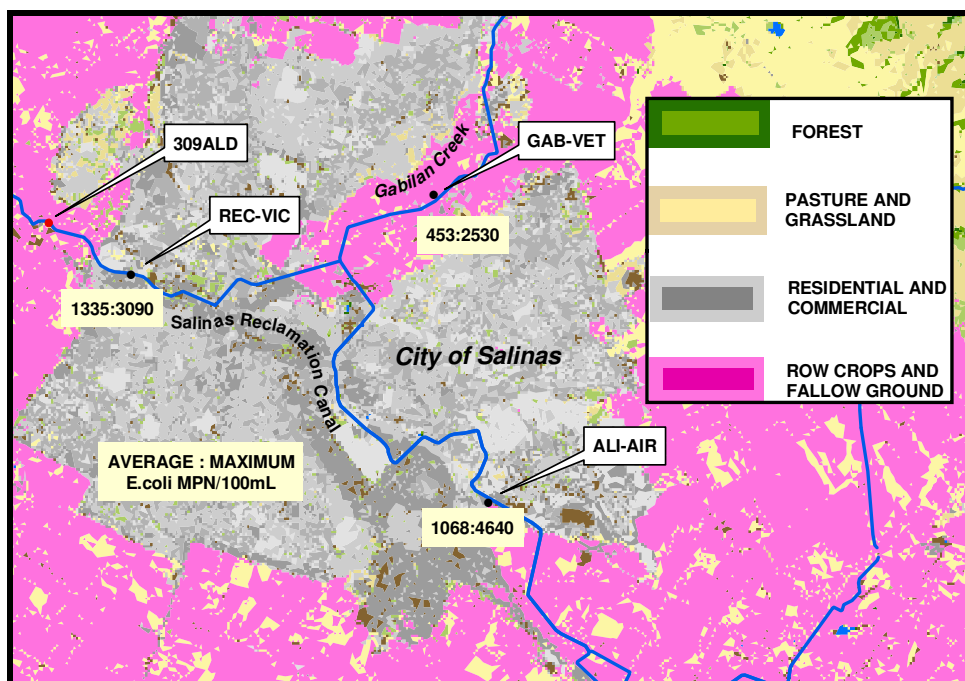


Figure 4-14 Average and maximum paired data from the Reclamation Canal and Gabilan Creek.

Note from the figure above that the average *E. coli* density at REC-VIC is greater than that of ALI-AIR. This might be counterintuitive, since the lower density of Gabilan (GAB-VET) should create a lower density at REC-VIC. However, the Reclamation Canal contains numerous stormwater discharge pipes, as illustrated in Figure 4-13, carrying urban sources of indicator bacteria. In addition, urban nonpoint sources of indicator bacteria are present, and could be contributing to the elevated density at REC-VIC. Storm water discharged to the Reclamation Canal is regulated through an existing NPDES permit for municipal storm water permitted to the City of Salinas.

An older dataset from CCAMP monitoring efforts includes monitoring site 309ALD, which is located downstream of REC-VIC approximately 0.75 miles (see Figure 4-14). The CCAMP dataset uses fecal coliform as the indicator bacteria. The more recent *E. coli* data set and the CCAMP data set are shown in Table 4-12.

**Table 4-12 Indicator bacteria data for Salinas Reclamation Canal.**

<b>REC-VIC</b>	<b>ECOLI</b>	<b>Exceedence of 298 MPN/100mL</b>	<b>Exceedence of 409 MPN/100mL</b>
10/25/05	2,419	X	X
11/15/05	602	X	X
12/13/05	76		
01/17/06	860	X	X
03/20/06	960	X	X
04/18/06	3,090	X	X
309ALD	Fecal Coliform MPN/100mL		
2/1/1999	17,000	X	X
3/1/1999	900	X	X
4/5/1999	3,000	X	X
5/10/1999	5,000	X	X
6/3/1999	160,001	X	X
7/7/1999	1,600	X	X
7/27/1999	500	X	X
8/31/1999	210		
9/28/1999	110		
11/2/1999	2,400	X	X
11/9/1999	160,001	X	X
11/30/1999	9,000	X	X
1/3/2000	3,000	X	X
1/26/2000	900	X	X
2/10/2000	90,000	X	X

It is clear from the data presented above that the Salinas Reclamation Canal exceeds the USEPA recommended density for water contact recreation.

Sources of indicator bacteria to the Salinas Reclamation Canal originate from a wide spectrum of land uses. Sources include those found in natural, rural, urbanized, and

agricultural landscapes. Table 4-13 identifies likely and potential sources of indicator bacteria in the Salinas Reclamation Canal.

**Table 4-13 Sources of indicator bacteria in the Salinas Reclamation Canal.**

Source	Land use
Human, pets, feral animals, leaking sewers, illicit connections.	Urban; Residential, Rural Residential, Commercial, Industrial
Livestock; including cattle, horses, goats, sheep, pigs, etc., faulty septic systems.	Pasture; Rural Residential
Livestock from land-applied manure.	Irrigated agriculture, Rural Residential
Uncontrollable sources, e.g. wildlife	All

### ***Tembladero Slough***

Tembladero Slough is contiguous with the Salinas Reclamation Canal. Tembladero Slough is a perennial waterbody receiving flow sources from agricultural return waters, urban runoff and stormwater, and tributary sources of the same from Espinosa Slough, Alisal Slough, and Merritt Channel.

Land uses surrounding Tembladero Slough are much like that of the Reclamation Canal, with row crops being the dominant land use. However, since Tembladero Slough is the receiving water body of the Salinas Reclamation Canal, Tembladero Slough also receives flows originating from a wide spectrum of land uses. Tembladero Slough flows northwesterly through row crop lands for about 1.5 miles, then flanks the town of Castroville before having a confluence with the Old Salinas River Lagoon. Tembladero Slough is the receiving water for numerous agricultural drains along its three-mile path. In addition, Tembladero Slough receives urban stormwater discharge from the town of Castroville.

There are two monitoring sites along the Tembladero Slough. Monitoring site TEM-PRE is located in the town of Castroville. Monitoring site TEM-MOL is located at the mouth of Tembladero Slough before its confluence with the Old Salinas River Lagoon. The monitoring sites are approximately two miles apart. Sources of flow to the Tembladero Slough between the monitoring sites are nearly exclusively from agricultural return water. This fact helps determine the contribution of indicator bacteria from irrigated lands.

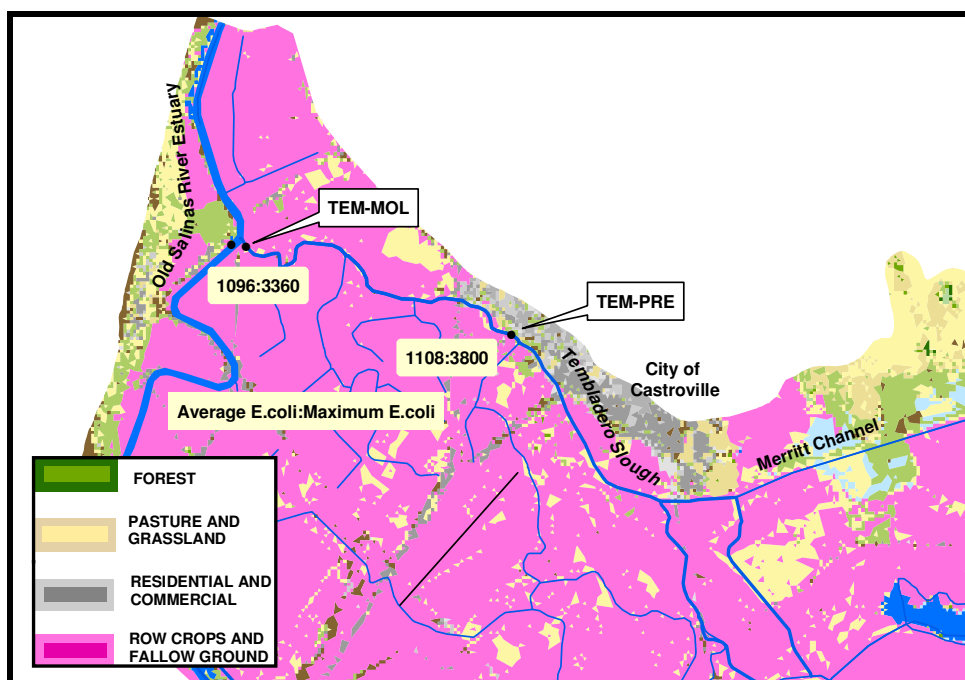


Figure 4-15 Average and maximum paired data of monitoring sites along Tembladero Slough.

Notice from Figure 4-15 that the average and maximum *E. coli* density between TEM-PRE and TEM-MOL are nearly the same. Also notice that row crop agriculture is the single dominant land use between the sites. Statistical analysis of paired data indicates that neither the average nor median *E. coli* densities between the two monitoring sites are statistically different. However, the median *E. coli* density between wet and dry months is significantly different ( $p = 0.0093$ ). Finally, although the median densities between wet and dry months are significantly different, the median densities during wet months of TEM-PRE and TEM-MOL are not statistically different. The statistical analysis is provided in the Appendix. These facts lead to the conclusion that sources of indicator bacteria in Tembladero Slough are being conveyed from sources upstream. Table 4-14 shows the median and average *E. coli* densities of TEM-PRE and TEM-MOL during the wet months.

Table 4-14 Median and average *E. coli* densities at monitoring sites in Tembladero Slough during wet months.

	Median <i>E. coli</i>	Average <i>E. coli</i>	
Site	MPN/100mL	MPN/100mL	Number of samples
TEM-MOL	1115	1373	14
TEM-PRE	1040	1342	14

The following conclusions can be drawn from the information and data:

- Row crop agriculture is not significantly increasing *E. coli* density in Tembladero Slough.
- A significant portion of *E. coli* in Tembladero Slough is being conveyed from upstream waters during wet months.
- Probable sources of indicator bacteria originating in the Tembladero Slough watershed include:
  - Urban sources, e.g. pets, feral animals, human
  - Wildlife.

### **Old Salinas River Estuary**

The Old Salinas River Estuary (Estuary) is the receiving water of the Tembladero Slough and the Salinas River Lagoon. Therefore flow and indicator bacteria sources to the Estuary are those from the Tembladero Slough and the Lagoon. In addition, irrigated row crops on all sides flank the Estuary.

Monitoring site OLS-MON is located immediately upstream of the confluence of the Estuary and Tembladero Slough.

Table 4-15 shows the data for monitoring site OLS-MON. Note from the data that USEPA recommendations for *E. coli* are exceeded. Also note that, like other monitoring sites and bodies of water in the Project area, the maximum density during wet months is greater than that of dry months. Furthermore, the maximum density observed occurred during wet weather.

The sources of indicator bacteria to the Estuary include sources from all the land uses upstream of the Estuary. Since the Salinas River Estuary is the receiving waterbody of the entire Project area, virtually all sources of indicator bacteria from the Project area could be sources in the Estuary.

Evidence of the wide range of sources to the Estuary includes the increased *E. coli* density during wet months, as is seen throughout the Project area. In addition, the occurrences of *E. coli* O157:H7 in the subwatersheds to the Estuary give evidence of the sources to the Estuary. *E. coli* O157:H7 has been identified at monitoring sites in the upper Gabilan watershed as well as downstream monitoring sites all the way down to the Estuary. Figure shows the occurrences of *E. coli* O157:H7. Note the hydrologic connectivity between the upper Gabilan areas to the Estuary. Seven monitoring sites tested positive for *E. coli* O157:H7 during a March 20, 2006 sampling event. These seven sites were along a stream thread beginning in the Gabilan watershed downstream to the Old Salinas River Estuary. Figure 4-16 illustrates the sites carrying the *E. coli* O157:H7 during the March 20, 2006 rain event, as well as the total number of occurrences of *E. coli* O157:H7 during the Project sampling period.

**Table 4-15 Monitoring data for the Old Salinas River Estuary.**

<b>OLS-MON</b>	<b>ECOLI</b>	Exceedence of 298 MPN/100mL	Exceedence of 409 MPN/100mL
11/09/04	256		
11/09/04	649	X	X
12/07/04	152		
01/12/05	2420	X	X
02/16/05	1120	X	X
03/23/05	2419	X	X
04/20/05	122		
06/20/05	1388	X	X
07/26/05	85		
08/16/05	866	X	X
10/25/05	170		
11/15/05	185		
12/13/05	600	X	X
01/04/06	1900	X	X
01/17/06	2590	X	X
03/07/06	410	X	X
03/20/06	573	X	X
04/18/06	310	X	
<b>Maximum (all data)</b>	<b>2590</b>		
<b>Avgerage (all data)</b>	<b>901</b>		
<b>Median (all data)</b>	<b>587</b>		
<b>Dry Max</b>	<b>1388</b>		
<b>Wet Max</b>	<b>2590</b>		



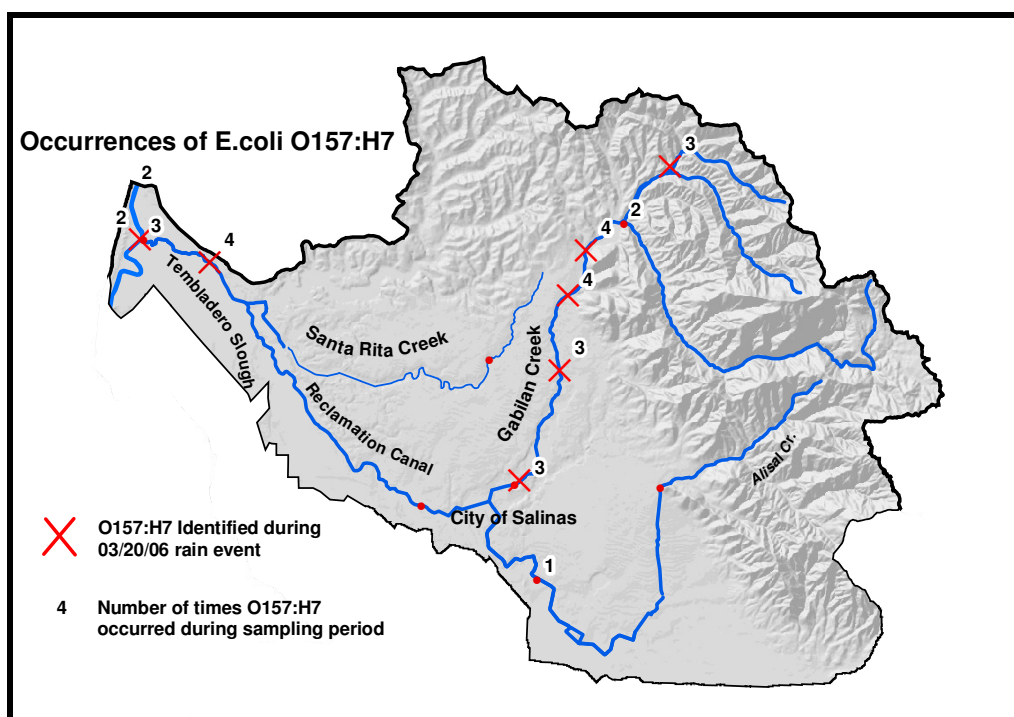


Figure 4-16 Occurrences of O157:H7 from Gabilan Creek downstream to the Estuary.

The probable sources of indicator bacteria to the Old Salinas River Estuary are shown in Table 4-16.

Table 4-16 Sources of indicator bacteria in the Old Salinas River Estuary.

Source	Land use
Human, pets, feral animals, leaking sewers, illicit connections.	Urban; Residential, Rural Residential, Commercial, Industrial
Livestock; including cattle, horses, goats, sheep, pigs, etc., faulty septic systems.	Pasture; Rural Residential
Livestock from land-applied manure.	Irrigated agriculture, Rural Residential
Uncontrollable sources, e.g. wildlife	All

## 4.7. Summary of Sources

Sources of indicator bacteria in the Project area are widespread across land uses. Areas that have not been developed or do not support livestock grazing carry *E. coli* densities well within the USEPA recommended levels for body contact. Forested and grassland areas with mixed land uses of rural residential and livestock grazing carry *E. coli* densities orders of magnitude in excess of USEPA recommended levels for body contact.

Gabilan and Alisal Creek subwatersheds support rural residential and livestock grazing lands. Maximum *E. coli* densities are in the tens of thousands. These maximum values are often associated with wet weather.

There is a statistically significant difference between wet and dry weather maximum and average *E. coli* densities; wet weather brings the highest levels of *E. coli* observed. *E. coli* O157:H7 has been identified in sediment, cloth sampling swabs placed in flowing creeks, and water samples from monitoring sites located in headwater areas immediately downstream from livestock access to riparian areas. Livestock have been identified as common carriers of *E. coli* O157:H7. Headwater areas also support rural residential land uses, which are potential sources of contamination from failing septic systems.

Waters adjacent to urban land uses, and urban stormwater, carry *E. coli* densities orders of magnitude in excess of USEPA recommended levels for body contact. Yet it is often in these settings that people, particularly children, may have contact with surface waters. Water Board staff have observed pet and human waste along urban surface waters. These sources have been confirmed by personal communication with City of Salinas staff.

All areas in the watershed have background, or natural, sources of indicator bacteria. However, based on *E. coli* densities observed in undeveloped headwater areas, the densities observed in developed headwater areas carry *E. coli* densities indicative of controllable source contamination.

Probable and identified sources of indicator bacteria in the Project area include:

1. Livestock
2. Urban sources, including:
  - a. Sources from regulated stormwater discharges, e.g.
    - i. Pets
    - ii. Feral animals
    - iii. Humans
    - iv. Illicit connections
    - v. Wildlife
    - vi.
  - b. Sources from residential, rural residential, commercial and industrial lands conveyed to surface waters by runoff, e.g.
    - i. Pets
    - ii. Feral animals
    - iii. Humans
    - iv. Livestock
    - v. Failing septic systems
    - vi. Wildlife
3. Non-permitted dumping
  - a. Indicator bacteria sources vary
4. Illegal point discharges.
5. Wildlife.

## **5. CRITICAL CONDITIONS AND SEASONAL VARIATION**

There is not an apparent critical condition for impairment. Impairment is watershed wide, spread across varying and unsuspecting land uses, flow conditions, and seasons.

Seasonal variation of indicator bacteria density occurs. Although impairment occurs in all seasons, maximum levels of indicator bacteria occur during and following rain events. Therefore, loading is greatest during wet weather.

Indicator bacteria may survive in the sediment for several months. Therefore, there may be a lag-affect between bacterial loading and resulting water column density; summer loading could affect winter water column indicator bacteria density. As such, allocations to achieve non-impairment will need to account for this lag-affect.

## 6. NUMERIC TARGET

The numeric target for this TMDL is based on protection of designated beneficial uses involving human water contact. The Water Quality Control Plan of the Central Coast Region (Basin Plan) refers to eight distinct bodies of water in the Project that are addressed with this Project. The eight bodies of water are listed in Table 1-1.

The Basin Plan defines two beneficial uses appropriate for the Project. The two beneficial uses are:

1. “Water Contact Recreation (REC-1): Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use or natural hot springs.”
2. “Non-Contact Water Contact Recreation (REC-2): Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.” (Water Quality Control Plan)

The Basin Plan designates numeric water quality objectives to protect these beneficial uses that are defined in Section 1.5. The numeric objectives are described in terms of fecal coliform, which are used as an indicator organism for the presence of other pathogenic organisms. USEPA recommends the use of *E. coli* as an indicator organism, and provides numeric criteria for the protection of water recreation beneficial uses. The use of *E. coli* as an indicator, relative to fecal coliform, is a newer criterion for the detection of pathogenic organisms. This project utilizes *E. coli* data, and therefore defines a TMDL numeric target using the USEPA recommendations.

USEPA does not designate specific water contact beneficial uses to the waterbodies in the Project area; each beneficial use is potential, leaving Water Board staff to determine the likelihood of each beneficial use.

Central Water Board staff (staff) has conducted reconnaissance and monitoring activities for two years in the Project area. Staff has not witnessed any full body water contact recreation in any of the waterbodies addressed in this Project. However, it is possible that some water contact recreation is occurring, even if infrequent. The numeric target, therefore, is based on “lightly used” full body water contact in the Project area. This approach yields a more conservative numeric target, relative to “infrequent” use, as shown in Table 6-1.

Note that the beneficial use REC-1 is not designated for the Salinas River downstream of Spreckles (Table 6-1), but does carry the REC-2 designation. The water quality objective

for the REC-2 designation is not as stringent as it is for REC-1 (refer to Section 1.5). However, the Salinas River Lagoon and the Old Salinas River Estuary are downstream of the Salinas River (downstream of Spreckles). Therefore, in order to protect the REC-1 designated use in the Lagoon and Estuary, or a similar USEPA use, the Salinas River downstream of Spreckles must be protected at the same level as the Lagoon and Estuary.

The Basin Plan (Central Coast) single sample water quality objective for the protection of the REC-1 beneficial use is 400 MPN/100mL of fecal coliform. The USEPA water quality criteria for “lightly used” full body water contact is 409 MPN/100mL *E. coli*. *E. coli* represent a large percentage of the fecal coliform group. Additionally, the difference between the fecal coliform objective of 400 MPN/100mL and the *E. coli* criteria of 409 MPN/100mL, is well-within the margin of potential error of approved laboratory methods (see Section 3.1). Therefore, the fecal coliform objective and the *E. coli* criteria are essentially equivalent standards; use of either as a numeric target does not constitute a relaxation of existing water quality standards.

The numeric target for all the waterbodies of the Project, as listed in Table 6-1, is a generic *E. coli* density of 409 MPN/100mL, expressed as a single sample maximum.

**Table 6-1 TMDL numeric target and beneficial use designation.**

<b>Numeric Targets for Project Waterbodies Based on Single Sample</b>		
	Water Contact type	Numeric Target <i>E. coli</i> MPN/100mL
<b>WATERBODY</b>	<i>Basin Plan Designation</i>	409
SALINAS RIVER (Chualar downstream to Spreckles)	<i>REC-1 REC-2</i>	409
SALINAS RIVER (downstream of Spreckles)	<i>REC-2</i>	409
SALINAS RIVER LAGOON (NORTH)	<i>REC-1 REC-2</i>	409
OLD SALINAS RIVER ESTUARY	<i>REC-1 REC-2</i>	409
TEMBLADERO SLOUGH	<i>REC-1 REC-2</i>	409
SALINAS RECLAMATION CANAL	<i>REC-1 REC-2</i>	409
GABILAN CREEK	<i>REC-1 REC-2</i>	409
ALISAL CREEK	<i>REC-1 REC-2</i>	409

(a) Water Board Staff recommended level of protection. Level used as basis of TMDL numeric target.

## **7. LINKAGE ANALYSIS**

The linkage analysis addresses the relationship between pollutant loading (*E. coli*) and water quality response (*E. coli* density, e.g. MPN/100mL). The source analysis and numeric target addresses the pollutant in terms of water quality response, and not mass loading. Consequently, the TMDL is expressed in terms of water quality response, and not mass loading.

Therefore, the TMDL demonstrates a linkage between pollutant loading and the resulting water quality response (*E. coli* density) by expressing the TMDL in terms of *E. coli* density.

## 8. TMDL CALCULATION AND ALLOCATIONS

### 8.1. TMDL

A total maximum daily load, or TMDL, is the loading capacity of a pollutant that a water body can accept while protecting beneficial uses. TMDLs can be expressed as mass loads over a period of time, e.g. pounds per day, as a density, or another appropriate measure [40 CFR §130.2(I)]. A density based TMDL is more appropriate for indicator bacteria because health risks associated with indicator bacteria are measured against density, and not mass.

Table 8-1 shows the TMDL for each of the waterbodies. The generic *E. coli* TMDLs for each of the waterbodies are equal to the numeric target, which is based on the USEPA recommended levels for water contact recreation.

*Allocation for Background:* The allocation to background is included in the waste load and load allocations. Therefore, the allocations below include the allocation to background.

**Table 8-1 TMDLs for waterbodies in Project area.**

<b>SALINAS RIVER (Chualar down- stream to Spreckles)</b>	<b>SALINAS RIVER (down-stream of Spreckles)</b>	<b>SALINAS RIVER LAGOON (NORTH)</b>	<b>OLD SALINAS RIVER ESTUARY</b>
TMDL for Single Sample maximum generic <i>E. coli</i> density (MPN/100mL)			
409	409	409	409
<b>TEMBLADERO SLOUGH</b>	<b>SALINAS RECLAMATION CANAL</b>	<b>GABILAN CREEK</b>	<b>ALISAL CREEK</b>
Single Sample maximum generic <i>E. coli</i> density (MPN/100mL)			
409	409	409	409

## **8.2. Waste Load and Load Allocations**

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An adaptive management strategy is necessary to achieve the TMDL and allocations. The allocation of indicator bacteria for each source necessary to achieve the TMDL may change from day to day, month to month, and year to year. Water quality response to loading is the result of numerous factors that cannot be predicted, e.g. rain frequency, rain intensity, seasonal temperatures, soil conditions, etc. Additionally, it is possible that fecal loading along stream banks of dry channels during summer months could result in exceedence of the numeric targets during wet months. This lag-effect, where water quality response occurs months after loading, is particularly pronounced during a “first-flush,” marking the beginning of the rain season.

The allocations are established to account for these unknowns. Setting the allocations equal to the numeric target, for all seasons, implies that loading cannot occur during any time that would result in exceedence of the numeric target, even if that exceedence occurs at a latter date.

The load allocations for all controllable sources of indicator bacteria are equal to the TMDL density. These sources cannot discharge or release a load of indicator bacteria that will cause an increase above the assimilative capacity of the waterbody. All areas in the Project area will held to these load allocations.

If all control measures are in place, and indicator bacteria densities remain above the TMDL density, then investigation will take place to determine if the high densities are due to natural sources. In this case, staff may consider re-evaluating targets and allocations.

Table 8-2 shows the load and waste load allocations to sources.



Table 8-2 Allocations

WASTE LOAD ALLOCATIONS		
Waterbody (see reference numbers in last row of table)	Sources to be allocated	Receiving Water Generic E. coli single-sample maximum density (MPN/100mL)
All affected	Urban Stormwater	≤ 409
All affected	Sewage Collection	≤ 409
LOAD ALLOCATIONS		Receiving Water E. coli single-sample maximum density (MPN/100mL)
All affected	Urban Non-point Sources	≤ 409
All affected	Illegal Dumping	≤ 409
All affected	Livestock	≤ 409
All affected	Non-Permitted Discharges to Surface Waters	
<b>Waterbodies:</b> 1: Salinas River, all reaches downstream of Gonzales River Road. 2: Salinas River Lagoon (north).      3: Old Salinas River Estuary. 4: Tembladero Slough.      5: Salinas Reclamation Canal. 6: Gabilan Creek.      7: Alisal Creek		

### 8.3. Margin of Safety

The margin of safety is a required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water (CWA 303(d)(1)(C)). For this TMDL, a margin of safety has been implicitly established through the use of protective numeric targets.

The uncertainties between the pollutant loading and water quality response stem largely from the uncertainties of sources of indicator bacteria. For example, staff has noted

illegal dumping throughout the Project area, but the level of indicator bacteria loading from illegal dumping is largely unknown. So also is the case of non-permitted discharges; many, perhaps most of the non-permitted discharges could be benign in terms of indicator bacteria.

There is widespread speculation that indicator bacteria may have a longer survival (relative to natural conditions) in nutrient and sediment rich channels holding agricultural return waters. Some stakeholders speculate that indicator bacteria could propagate in agricultural ditches. At this time, this speculation cannot be defended or refuted, and is therefore an uncertainty.

Although uncertainties exist, the nature of a density (or concentration) based TMDL and allocations accounts for uncertainties insofar as indicator bacteria loading, from known and unknown sources alike, cannot be such that the resulting water quality exceeds the TMDL. This approach, along with adaptive management strategy towards achieving the TMDL, accounts for the nexus between pollutant loads and resulting water quality.

Also, the numeric targets for the TMDL are equal to the USEPA recommended levels. USEPA recommended levels for *E. coli* are established with the knowledge of predicted and acceptable risk of the recommended level. Since the numeric targets are equal to these USEPA recommended *E. coli* levels, and the recommended levels carry calculated and acceptable risk, the TMDL has an implicit margin of safety.

## **9. PUBLIC PARTICIPATION**

Water Board staff (staff) has conducted stakeholder outreach efforts throughout the Project inception. Staff has worked closely with county, state, and federal agencies during the data collection and data analysis phases. Results of coordinated efforts have been publicized in newspapers and television media.

Staff has made several presentations during the development of the TMDL. Attendees of the presentations included representatives from the following:

- United Fresh Fruit and Vegetable Association
- Monterey County Department of Environmental Health
- State of California Department of Health Services
- United States Department of Agriculture
- United States Food and Drug Administration

Staff conducted a California Environmental Quality Act (CEQA) stakeholder scoping meeting on [REDACTED]. Staff addressed questions and comments from attendees. Staff also informed stakeholders of their right to submit written comment during the comment period before the Regional Board hearing of the TMDL. There was a 45-day comment period preceding the Regional Board hearing. Written comments were received, staff's written responses were provided for public access before the Regional Board hearing of the TMDL.

## 10. IMPLEMENTATION PLAN

### 10.1. Introduction

The objective of the Implementation Plan (Plan) is to describe courses of action leading to achieving the TMDL. The sources of indicator bacteria in the Project area have been discussed in the previous sections. Knowledge of the origins and means of conveyance of sources to surface waters help staff determine regulatory mechanisms and actions that can be used to reduce bacterial loading. The mechanisms and actions are discussed in this section.

### 10.2. Potential Implementation Mechanisms

The Water Board recognizes that existing efforts are helping to control the discharge of indicator bacteria in surface waters of the Project area. Existing efforts include, but are not limited to:

1. Implementation of the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Conditional Waiver).
2. Existing Waste Discharge Requirements of facilities in the Project area.
3. Existing National Pollutant Discharge Elimination System (NPDES) permits for stormwater and other discharges in the Project area.
4. Existing best management practices of individuals and entities in the Project area.
5. Good land-stewardship of individuals and entities in the Project area.

#### ***Nonpoint Sources***

Actions that address bacterial reductions from nonpoint sources must be consistent with the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program [NPS Program] (SWRCB, 2004). The NPS Program states that nonpoint sources of pollution must be addressed through one of the following:

1. Waste Discharge Requirements (WDRs)
2. Waiver of Waste Discharge Requirements
3. Prohibitions.

The Nonpoint Source Implementation and Enforcement Policy, adopted as state law in August 2004, requires the Regional Water Boards to regulate all nonpoint sources of pollution using the administrative permitting authorities provided by the Porter-Cologne Act. Dischargers must comply with Waste Discharge Requirements (WDRs), waivers of WDRs, or Basin Plan Prohibitions, by participating in the development and implementation of *Nonpoint Source Pollution Control Implementation Programs*, either individually or collectively as participants in third-party coalitions. The “third-party” *Programs* are restricted to entities that are not actual discharges under Regional Water

Board permitting and enforcement jurisdiction. These may include Non Governmental Organizations, citizen groups, industry groups, watershed coalitions, government agencies, or any mix of the above. All *Programs* must meet the requirements of the following (Five) Key Elements described in the NPS Implementation and Enforcement Policy. Each *Program* must be endorsed or approved by the Regional Water Board.

- Key Element 1:** A *Nonpoint Source Pollution Control Implementation Program's* ultimate purpose must be explicitly stated and at a minimum address NPS pollution control in a manner that achieves and maintains water quality objectives.
- Key Element 2:** The *Program* shall include a description of the management practices (MPs) and other program elements dischargers expect to implement, along with an evaluation program that ensures proper implementation and verification.
- Key Element 3:** The *Program* shall include a time schedule and quantifiable milestones, should the Regional Water Board require these.
- Key Element 4:** The *Program* shall include sufficient feedback mechanisms so that the Regional Water Board, dischargers, and the public can determine if the implementation program is achieving its stated purpose(s), or whether additional or different MPs or other actions are required (See Section 10, Monitoring Program).
- Key Element 5:** Each Regional Water Board shall make clear, in advance, the potential consequences for failure to achieve a *Program's* objectives, emphasizing that it is the responsibility of individual dischargers to take all necessary implementation actions to meet water quality requirements (SWRCB, 2004a).

Examples of nonpoint sources of indicator bacteria in the Project area include:

- Livestock
- Non-permitted discharges

### ***Point Sources***

Point discharges are regulated through NPDES permits. The Water Board issues NPDES permits to dischargers meeting the necessary requirements.

Information needed to obtain an NPDES permit includes, but is not limited to:

1. Filing the appropriate NPDES application forms with the Water Board and USEPA.
2. Facility name, address, and phone number.
3. Topographic map of facilities features.
4. Identification of pollutant characteristics.
5. Production, operation and discharge information specific to the type of facility.

Approval of NPDES permits requires legal public review and approval of the Water Board.

Examples of point discharges include:

- Urban stormwater discharges.
- Leaks from sewage collection systems

### ***Regulatory Authority of the Regional Board***

California's Porter-Cologne Water Quality Control Act establishes the responsibilities and authority of the Regional Water Quality Control Boards (Water Board). The Water Board is charged with the coordination and control of water quality in the Project Area. The Water Board implements portions of the Federal Clean Water Act, such as the NPDES and toxic substances control programs.

The Porter-Cologne and Clean Water Acts describe how enforcement of waste discharge regulations are to be carried out. Enforcement tools range from simple letters to dischargers, to civil and/or criminal penalties. For most actions, legally noticed public hearings are required. However, some enforcement actions (e.g. Cleanup and Abatement Orders), can be administered by Water Board staff.

## **11. MONITORING PLAN**

Water quality monitoring is needed to gauge progress towards achieving the TMDL and individual allocations. Monitoring will be required pursuant to existing or anticipated regulatory mechanisms, e.g. NPDES permits, WDRs, prohibitions, waivers, and other authorities granted to the Executive Officer of the Regional Board under the Porter-Cologne Water Quality Control Act. The details of monitoring, e.g. location, frequency, and analysis will be articulated in the regulatory mechanisms requiring the monitoring.

It is anticipated that required monitoring will consider the following:

1. All 303(d) listed waterbodies in the Project area (i.e., listed for fecal coliform or pathogens), and/or those not achieving water quality standards. Including:
  - a. The Salinas River from Gonzales to the Salinas River Lagoon
  - b. The Salinas River Lagoon
  - c. The Old Salinas River Estuary
  - d. The Salinas Reclamation Canal
  - e. Gabilan Creek
  - f. Alisal Creek
2. Identified sources, including:
  - a. Urban sources (stormwater and overland flow).
  - b. Livestock
3. Seasonal variations.

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Water Quality Control Plan, Central Coast Region



<b>APPENDIX A: SHELL USE ATTAINABILITY ANALYSIS</b>
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To be inserted when completed in September 2006.

## **APPENDIX B: LAND USE INFORMATION AND STATISTICAL ANALYSIS**

### **NLCD Land Use Information used in GIS layers**

11. Open Water - areas of open water, generally with less than 25 percent or greater cover of water (per pixel).

12. Perennial Ice/Snow - All areas characterized by year-long cover of ice and/or snow.

Developed - areas characterized by high percentage (approximately 30% or greater) of constructed materials (e.g. asphalt, concrete, buildings, etc).

21. Low Intensity Residential - Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.

22. High Intensity Residential - Includes heavily built up urban centers where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80-100 percent of the cover.

23. Commercial/Industrial/Transportation - Includes infrastructure (e.g. roads, railroads, etc.) and all highways and all developed areas not classified as High Intensity Residential.

Barren - Areas characterized by bare rock, gravel, sand, silt, clay, or other earthen material, with little or no "green" vegetation present regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive.

31. Bare Rock/Sand/Clay - Perennially barren areas of bedrock, desert, pavement, scarps, talus, slides, volcanic material, glacial debris, and other accumulations of earthen material.

32. Quarries/Strip Mines/Gravel Pits - Areas of extractive mining activities with significant surface expression.

33. Transitional - Areas of sparse vegetative cover (less than 25 percent that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.)

Forested Upland - Areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); Tree canopy accounts for 25-100 percent of the cover.

41. Deciduous Forest - Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest - Areas characterized by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. Mixed Forest - Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

Shrubland - Areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall with individuals or clumps not touching to interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

51. Shrubland - Areas dominated by shrubs; shrub canopy accounts for 25-100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases when the cover of other life forms (e.g. herbaceous or tree) is less than 25 percent and shrubs cover exceeds the cover of the other life forms.

Non-natural Woody - Areas dominated by non-natural woody vegetation; non-natural woody vegetative canopy accounts for 25-100 percent of the cover. The non-natural woody classification is subject to the availability of sufficient ancillary data to differentiate non-natural woody vegetation from natural woody vegetation.

61. Orchards/Vineyards/Other - Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

Herbaceous Upland - Upland areas characterized by natural or semi-natural herbaceous vegetation; herbaceous vegetation accounts for 75-100 percent of the cover.

71. Grasslands/Herbaceous - Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.

Planted/Cultivated - Areas characterized by herbaceous vegetation That has been planted or is intensively managed for the production of food, feed, or fiber; or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75-100 percent of the cover.

81. Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.

82. Row Crops - Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.

83. Small Grains - Areas used for the production of graminoid crops such as wheat, barley, oats, and rice

84. Fallow - Areas used for the production of crops that are temporarily barren or with sparse vegetative cover as a result of being tilled in a management practice that incorporates prescribed alternation between cropping and tillage.

85. Urban/Recreational Grasses - Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

Wetlands - Areas where the soil or substrate is periodically saturated with or covered with water as defined by Cowardin et al.

91. Woody Wetlands - Areas where forest or shrubland vegetation accounts for 25-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

92. Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

### **Statistical Analysis: Rain vs Nonrain**

5/4/2006 11:01:03 AM

5/4/2006: A test to determine whether the medians of the samples taken during two rain events is greater than the mean of the samples taken during a nonrain sampling event. The test does not require a normal distribution, and the pairs do not need to be matched. However, in order to avoid bias, I only used data where a rain event sample was followed by a nonrain event sample.

The P-value shows that the medians are not equal. Since the mean of rain samples is greater, the mean of samples from rain sampling is statistically greater than the mean of samples taken from nonrain sampling events.

### **Mann-Whitney Test and CI: RainSamples, NonrainSamples**

```

RainSamp   N = 20      Median =      2685.0
NonrainS   N = 20      Median =       223.5
Point estimate for ETA1-ETA2 is      2408.0
95.0 Percent CI for ETA1-ETA2 is (1459.8,4623.8)
W = 561.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0000
The test is significant at 0.0000 (adjusted for ties)

```

.....

Here is the Mann-Whitney test using the  $H_a$  that the RainSamples have a greater median.

### Mann-Whitney Test and CI: RainSamples, NonrainSamples

```

RainSamp   N =   20      Median =      2685.0
NonrainS   N =   20      Median =       223.5
Point estimate for ETA1-ETA2 is      2408.0
95.0 Percent CI for ETA1-ETA2 is (1459.8,4623.8)
W = 561.0
Test of ETA1 = ETA2   vs   ETA1 > ETA2 is significant at 0.0000
The test is significant at 0.0000 (adjusted for ties)

```

Here is the Paired-t test testing the means of rain vs nonrain data.

### Paired T-Test and CI: RainSamples, NonrainSamples

Paired T for RainSamples - NonrainSamples

	N	Mean	StDev	SE Mean
RainSamples	20	3860	3288	735
NonrainSampl	20	555	811	181
Difference	20	3306	3406	762

95% CI for mean difference: (1712, 4899)  
 T-Test of mean difference = 0 (vs not = 0): T-Value = 4.34 P-Value = 0.000

Data used in analysis:

	RainSamples	NonrainSamples
ALI-AIR	12590	120
GAB-CRA	2620	249
GAB-HER	4730	121
GAB-NAT	2750	520
GAB-OSR	323	31
GAB-VET	5630	100
OLS-MON	410	573
SAL-BLA	95	52
SAL-DAV	323	168
SRC-COR	1710	3270
TEM-MOL	1600	246
TEM-PRE	1610	1450
TOW-OSR	4040	384
GAB-CRA	6570	201
GAB-HER	6200	168
GAB-NAT	7570	1970
GAB-OSR	2280	31
SAL-DAV	2460	52
TEM-PRE	8820	630
TOW-OSR	4870	754

### **Statistical Analysis: Comparing medians and means of E. coli paired data between TEM-PRE and TEM-MOL.**

6/27/2006 1:54:54 PM

#### **Mann-Whitney Test and CI: PreEcoli, MolEcoli**

PreEcoli N = 18 Median = 408.0  
 MolEcoli N = 18 Median = 278.0  
 Point estimate for ETA1-ETA2 is 83.5  
 95.2 Percent CI for ETA1-ETA2 is (-376.0, 396.9)  
 W = 354.0  
 Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5166  
 The test is significant at 0.5162 (adjusted for ties)

Cannot reject at alpha = 0.05

#### **Mann-Whitney Test and CI: MolEcoli, PreEcoli**

MolEcoli N = 18 Median = 278.0  
 PreEcoli N = 18 Median = 408.0  
 Point estimate for ETA1-ETA2 is -83.5  
 95.2 Percent CI for ETA1-ETA2 is (-396.9, 376.0)  
 W = 312.0  
 Test of ETA1 = ETA2 vs ETA1 > ETA2  
 Cannot reject since W is < 333.0

#### **Mann-Whitney Test and CI: PreEcoli, MolEcoli**

PreEcoli N = 18 Median = 408.0  
 MolEcoli N = 18 Median = 278.0  
 Point estimate for ETA1-ETA2 is 83.5  
 95.2 Percent CI for ETA1-ETA2 is (-376.0, 396.9)  
 W = 354.0  
 Test of ETA1 = ETA2 vs ETA1 > ETA2 is significant at 0.2583  
 The test is significant at 0.2581 (adjusted for ties)

Cannot reject at alpha = 0.05

#### **Two-Sample T-Test and CI: MolEcoli, PreEcoli**

Two-sample T for MolEcoli vs PreEcoli

	N	Mean	StDev	SE Mean
MolEcoli	18	1096	1191	281
PreEcoli	18	1108	1132	267

Difference = mu MolEcoli - mu PreEcoli  
 Estimate for difference: -12  
 95% CI for difference: (-799, 775)  
 T-Test of difference = 0 (vs not =): T-Value = -0.03 P-Value = 0.976 DF = 34  
 Both use Pooled StDev = 1162

**Paired T-Test and CI: MolEcoli, PreEcoli**

Paired T for MolEcoli - PreEcoli

	N	Mean	StDev	SE Mean
MolEcoli	18	1096	1191	281
PreEcoli	18	1108	1132	267
Difference	18	-12	822	194

95% CI for mean difference: (-421, 397)

T-Test of mean difference = 0 (vs not = 0): T-Value = -0.06 P-Value = 0.952

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Region 3\Salinas River\Fecal coliform\4 Project Analysis\  
MINITAB.MTW

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Projects- Region 3\Salinas River\Fecal coliform\4 Project Analysis\MINITAB.MPJ

TEM- MOL	MolEcoli	TEM-PRE	PreEcoli
11/9/2004	179	11/9/2004	272
11/9/2004	203	11/9/2004	326
12/7/2004	1986	12/7/2004	2419
1/12/2005	2420	1/12/2005	2420
2/16/2005	2420	2/16/2005	2420
3/23/2005	2419	3/23/2005	2419
4/20/2005	233	4/20/2005	373
6/20/2005	74	6/20/2005	345
7/26/2005	111	7/26/2005	325
8/16/2005	210	8/16/2005	416
10/25/2005	110	10/25/2005	74
11/15/2005	122	11/15/2005	161
12/13/2005	630	12/13/2005	84
1/4/2006	3100	1/4/2006	3800
1/17/2006	3360	1/17/2006	400
3/7/2006	1600	3/7/2006	1610
3/20/2006	246	3/20/2006	1450
4/18/2006	310	4/18/2006	630

**Mann-Whitney Test and CI: WET, DRY**

WET            N = 14            Median =            1115.0

DRY                N =     8            Median =            160.5  
 Point estimate for ETA1-ETA2 is            870.0  
 95.6 Percent CI for ETA1-ETA2 is (48.0,2309.2)  
 W = 196.0  
 Test of ETA1 = ETA2 vs ETA1 > ETA2 is significant at 0.0093  
 The test is significant at 0.0092 (adjusted for ties)

PRE AND MOL WET	WET	PRE AND MOL DRY	DRY
11/09/04	179	06/20/05	74
11/09/04	203	07/26/05	111
12/07/04	1986	08/16/05	210
01/12/05	2420	10/25/05	110
02/16/05	2420	06/20/05	345
03/23/05	2419	07/26/05	325
04/20/05	233	08/16/05	416
11/15/05	122	10/25/05	74
12/13/05	630		
01/04/06	3100		
01/17/06	3360		
03/07/06	1600		
03/20/06	246		
04/18/06	310		

### Mann-Whitney Test and CI: WetMOL, WetPRE

WetMOL        N =    14        Median =        1115.0  
 WetPRE        N =    14        Median =        1040.0  
 Point estimate for ETA1-ETA2 is            0.0  
 95.4 Percent CI for ETA1-ETA2 is (-820.0,970.1)  
 W = 200.5  
 Test of ETA1 = ETA2 vs ETA1 < ETA2 is significant at 0.4634  
 The test is significant at 0.4633 (adjusted for ties)

Cannot reject at alpha = 0.05

TEM- MOLwet	WetMOL	TEM-PREwet	WetPRE
11/09/04	179	11/09/04	272
11/09/04	203	11/09/04	326
12/07/04	1986	12/07/04	2419
01/12/05	2420	01/12/05	2420
02/16/05	2420	02/16/05	2420
03/23/05	2419	03/23/05	2419
04/20/05	233	04/20/05	373



11/15/05	122	11/15/05	161
12/13/05	630	12/13/05	84
01/04/06	3100	01/04/06	3800
01/17/06	3360	01/17/06	400
03/07/06	1600	03/07/06	1610
03/20/06	246	03/20/06	1450
04/18/06	310	04/18/06	630